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Micro/Systems Journal™

For the Advanced Computer User

Memory Addressing on the 80386

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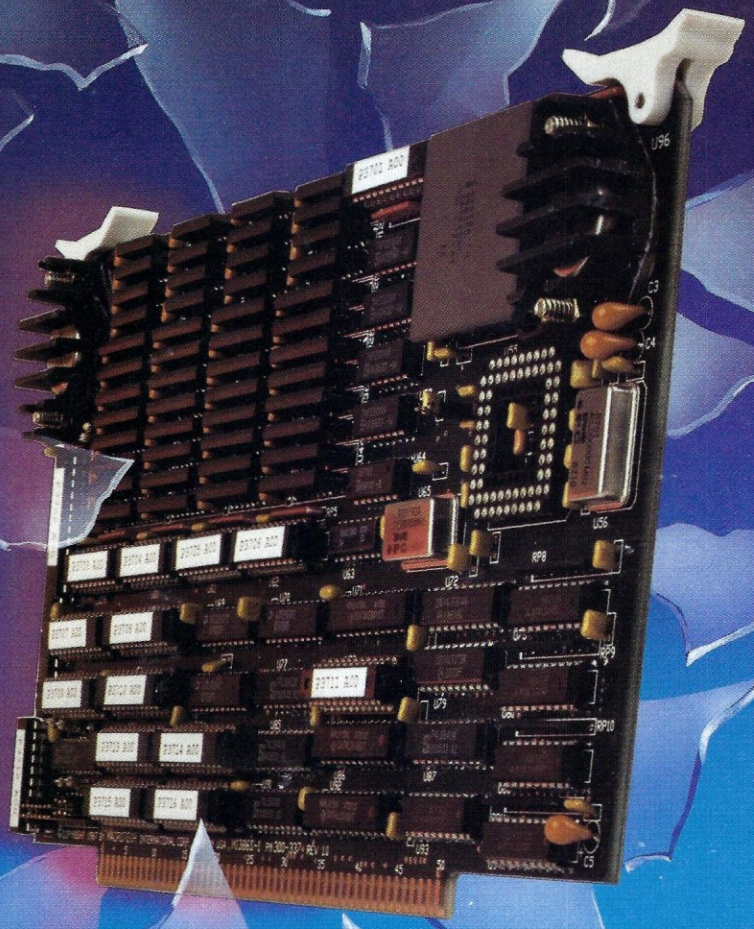

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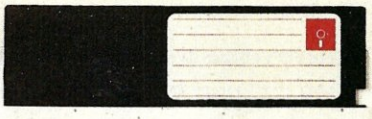

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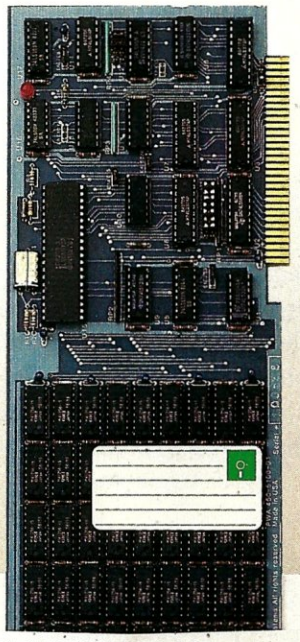

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Micro/Systems Journal™

For the Advanced Computer User

About the cover: *Systems based on Intel's 32-bit 80386 microprocessor are arriving in significant numbers. Systems with the processing power of minicomputers now sit on the desktop. In this issue we review three hardware implementations and two multitasking/multiuser operating systems that exploit the features of the 386.*

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Editor's Page

Sol Libes

Will The 386 Leapfrog The 286?

It is estimated that by the end of the year more than 200,000 80386 systems will be running DOS applications. By the end of next year, that number may reach one million. The combination of higher clock speed, 80387 math coprocessor, and caching circuitry enable these machines to run standard DOS and DOS applications at two to four times the speed of an IBM PC/AT. When 32-bit software is run, speed will improve by several times this amount.

Three of the very early 386 hardware products are reviewed in this issue. We will be reviewing more in upcoming issues, including complete 386 systems, 386 accelerator cards, and 386 piggyback boards.

OS/2, the new operating system for the PS/2 series from IBM/Microsoft, is still not here yet and is not expected for several more months. Although it will have added features such as multitasking, increased memory addressing, and larger disk drive management, it is nevertheless a 286 operating system. This means it will have limitations and problems and it will not be able to take advantage of the 386's architecture. Steve Ballmer, manager of system software at Microsoft, has called the 286 a "brain-damaged" processor.

In the meantime, several 386 operating systems have already arrived. Two are reviewed in this issue, and several more will be released shortly. We will be reviewing them and related products in future issues. The 386 is an excellent device for multiuser systems, and we can expect to see several implementations of UNIX.

Some software publishers have taken another tack. They have written 386 extensions to DOS. This approach enables a user to run standard DOS Version 3.2 as the operating system and to run one or more 386 32-bit application programs. Examples of such extensions are DESQview Version 2.0, the PharLap 386/DOS-Extender, and A.I. Architects OS/386 DOS extension.

A large number of 32-bit 386 software development packages have already been released. PharLap Software and Microsoft have released 386 assembler/linker packages. MetaWare has introduced both C and Pascal compilers. And Lahey has released a 32-bit version of their popular FORTRAN-77.

The combination of 386 hardware and software means that mainframe processing speeds and capabilities will now be available on desktop machines. Sources at A.I. Architects, for example, claim that the performance of its 386 HummingBoard running at 20 MHz executes the Dhrystone C benchmarks (registers) 5.8 times faster than a DEC VAX-11/780, 1.3 times faster than a DEC VAX-8600, and 1.5 times faster than an IBM 4381-2. This XT/AT plug-in card contains 16/20 MHz 386, 387, memory cache, and 2 to 24 Mbytes RAM.

There is a general feeling in the industry that software developers will leapfrog over the 286 and concentrate on developing software for the 386. The reason for this is that the 386 is designed for true multitasking whereas the 286 is not. IBM and Microsoft have already indicated that PC application software will require extensive modification to run in the multitasking protected mode of the OS/2 (a 286-based operating system).

The 386 provides a third mode of operation: the virtual mode, which allows multiple 8086 address spaces to be created, each protected from the others and from the operating system. Thus, most 8086 applications will execute without modification, and no matter how badly behaved an application is, it will not affect other applications. This means that one can have several multiple terminate-and-stay-resident (TSR) programs (for example, Sidekick) without having a conflict, and the features of TSR programs can be greatly expanded. Communications programs will be able to run comfortably in the background, and data interchange between applications can occur without having to go in and out of each application.

Application software reportedly will run more slowly under the OS/2-protected mode than it does under 386 DOS extension software running in protected mode or virtual mode.

The amount of application software that will be available to run under OS/2 Version 1.0 will probably be limited, as many software developers see OS/2 as an interim product.

Another interesting 386 development is the introduction of UNIX with Microport's DOS-Merge/386, which allows the running of multiple MS-DOS programs in an emulation mode. These new UNIX implementations also include Ethernet controllers, TCP/IP, and Sun Microsystems NFS networking and X Window support. These last facilitate the movement of graphics-oriented displays around a network of dissimilar systems. §

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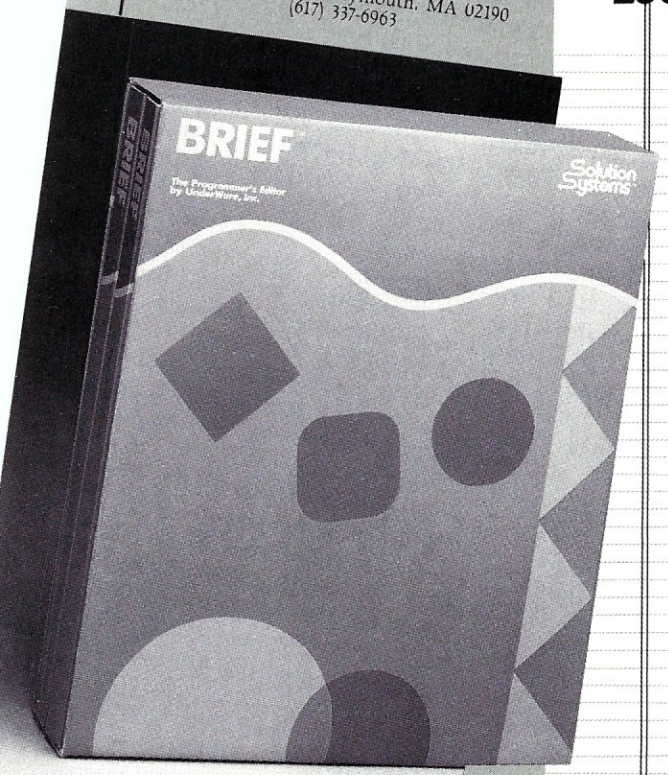

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News, Views & Gossip

by Sol Libes

Random Gossip & Rumors

Don't junk those old PC or XT clunkers! It is rumored that **Intel** is readying an XT version of its Inboard-386/AT card to sell for about $700 (with zero memory) and just under $1,000 with a Megabyte of RAM on board. Replace the old CGA display with a VGA card and display and the machine will run OS/2 as well, or better, than a new IBM PS/2 Model 50 costing more than three times the price. Or, try an XT replacement 386 motherboard. There are already a half-dozen available. (What a potential market! With about 9 million PCs and XTs waiting to be upgraded to the 386, expect to see specialty dealers whose only business will be reworking PCs and XTs.)

Also look for **Compaq** to shortly introduce a 386-based portable computer to scoop **IBM**'s introduction of a 286-based portable. Two 386 portables are already being marketed by **PC Discount** (Houston, Texas) and **Storage System Engineering Service** (Santa Clara, Calif.).

Paradise Systems (San Francisco, Calif.) is reportedly shipping sample quantities of a single-chip VGA display controller to OEMs. Several PC clone makers are expected to show machines at the November Comdex trade exhibition. These units will include this chip, along with 3½-inch drives, to run OS/2 with a PS/2-compatible BIOS. The question now is whether they will advertise these systems as PC- or PS/2-compatible systems?

IBM is expected to announce a replacement for the RT in February. It is rumored to be the PS/2 Model 90, which will use either a 20-MHz 386 or new RISC processor and an extended VGA controller. It is expected to compete against the new Sun Microsystems RISC and DEC MicroVax-III systems.

IBM also is expected to release versions 3.4 and 3.5 of PC-DOS shortly. Version 3.4 reportedly fixes some 3.3 bugs, and 3.5 will contain drivers for new large capacity hard disk drives/controllers.

Apple is said to be developing an 80386 coprocessor card for its hot-selling new Mac-II system. Reports indicate that the Mac-II and Mac-SE are gaining significant acceptance in the corporate world.

Word has it that **Microsoft** has begun development of a 386 version of OS/2, with possible release scheduled as early as the first quarter of 1989.

Atari is rumored to be developing a new desktop system designed to serve the workstation market. However, Atari's new system is based on the Transputer 32-bit microprocessor from England rather than the Motorola 68020. The Transputer boasts performance that is four times better than the 68020. The big problem, however, may not be the hardware design but the software. First and foremost is the development of an operating system—the likelihood is that it will be a port of UNIX. There are reports that prototypes of this system have already been seen at Atari. Then again, there have been other times that Jack Tramiel has shown a prototype product that never made it into production.

QMS (**Quality Micro Systems** of Mobile, Ala.) is said to be readying the first color laser printer for introduction by the end of this year. The price is expected to be somewhere between $20,000 and $30,000.

The Business of Software and Micros

Microsoft has been referred to as a "software monopoly." This label probably comes from the company's large number of recent acquisitions, and Bill Gates' belief that there is a need for Microsoft to compete in virtually every software market. However, if one looks at the software sales figures, Microsoft is far from the number one market position needed for a monopoly. The title would better fit IBM.

Datamation magazine's recent study of software companies showed that Microsoft ranked only eleventh in the field. Although sales for 1986 increased 60 percent over the previous year to more than $260 million, Microsoft was far behind the leaders: IBM (more than $5.5 billion), Unisys ($861 million), DEC ($560 million), NEC ($507 million), Fujitsu ($389 million), Siemens ($387 million), Hewlett-Packard ($375 million), Hitachi ($331 million), Nixdorf ($299 million), and Lotus ($283 million).

It should be noted that five of the top ten software companies in the survey were foreign, including three Japanese firms.

By contrast, Datamation's recent study of the top micro manufacturers indicated that of the top ten, only three were foreign companies, and two of those were Japanese. Naturally, IBM led the field ($5.65 billion), followed by Apple ($1.8 billion), Olivetti ($1.3 billion), Tandy ($997 million), Unisys ($800 million), NEC ($697 million), Compaq ($625 million), AT&T ($600 million), Toshiba ($581 million), and Zenith ($548 million).

Micros are now a substantial part of IBM's business. Last year, IBM did in excess of $48.5 billion in sales, of which the largest single area was still mainframe sales ($14.45 billion). Peripheral sales were second (more than $11.2 billion), and maintenance third (more than $7.4 billion). Micros ranked fourth, and software sales ranked fifth. However, software showed the biggest growth for IBM last year and probably will over overtake IBM's micro and maintenance business this year. While hardware prices have gone down, software prices have gone up.

80386 Versus the 68020

When **IBM** announced its PS/2 Model 80, a 386-based system, much earlier than expected and began shipping units months earlier than expected, it was not to meet the competitive challenge offered by the Compaq DeskPro 386. Rather, it was Apple's Mac-II that had IBM worried. **Apple**, number two in the microcomputer game (see story below), showed a healthy sales increase of 11.1 percent last year compared to IBM's small 2.7 percent increase. At the same time, Apple's market share increased while IBM's share decreased. Further, most of Apple's share increase has been in the business area. By comparison, Compaq ranks seventh in the micro race and is essentially an IBM cloner, which makes the company vulnerable to IBM's changing marketing tactics.

Both IBM's and Apple's new systems are based on 32-bit microprocessor chip sets; the Intel 80386 versus the Motorola 68020. The systems are designed for multiprocessing workstations with color graphics windowing user interfaces. If you compare their respective features and specs, you can note their similarities. IBM hopes that the PS/2 Model 80 with OS/2 V1.1 will head off the Mac-II, in the same way the PC stopped the Apple-II's advancement into the business community in the early 80's. The model 80 with OS/2 is designed to be a "Mac-II killer."

However, Apple is once again proving itself the technological leader in the PC marketplace. The Mac has grown from a plaything to a sophisticated system. For

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example, Apple's new Multifinder software brings Presentation Manager-type multiprocessing to the Mac more than a year before it will appear on the IBM PS/2. And Apple's new HyperCard software introduces a new, powerful, easy-to-use, graphics-oriented database management system for the Mac. Business users now have another reason, beside easy-to-use desktop publishing and powerful graphics development, to buy the Mac.

One of the most important features of these systems are their compatibility with the models that preceded them. In the case of IBM, it was compatibility with the PC/AT (based on the 80286) and DOS. In the case of the Mac-II, it was compatibility with the Mac-I (based on the 68000). Both the PS/2 Model 80 and Mac-II can run software designed for their predecessors. However, OS/2 with the Presentation Manager will require substantial rewrites of current DOS software while Apple's new Multifinder can multiprocess most of the old Mac software.

On to the Next Generation

Both **Intel** and **Motorola** are already hard at work on their next generation of microprocessors, and IBM and Apple are designing their next generation of micros. Intel is rumored to have already shipped early prototype 80486 samples to IBM. Intel is promising that the 486 will be software-compatible with the 386.

Motorola, on the other hand, has disclosed that its 78000, will be a non-compatible, RISC-based device. Motorola is taking a real gamble here by abandoning software-compatibility. Intel discovered this several years ago when it introduced the 432, a 32-bit chip set, with a very advanced architecture. But, the 432 was not compatible with Intel's popular 8086 16-bit device. System designers had to start from ground zero on a whole new learning curve, and very few companies were willing to make the necessary long-term investment. With so few companies interested in the 432, Intel could not make its own investment in support for these devices.

Fortunately, Intel recognized its mistake early and redirected its R&D efforts into the 286 and 386. Although the 286 and 386 represented a step backward in terms of technology when compared to the 432, they proved to be what the market wanted and they put Intel back into profitability. Let's hope that the Motorola 78000 does not end up impaled on the cutting edge of technology the way the Intel 432 did.

OS/2 News

Microsoft is waging a promotional campaign for OS/2 and its Presentation Manager, the scale of which we have never before seen in the personal computer industry. Almost a year before the product was to be released, Microsoft began conducting seminars and selling software developer kits, which included a beta version of OS/2 Version 1.0 (without the Presentation Manager). By early July, they had already sold an estimated 2,000 developers kits at $3,000 each, and they will probably sell another 2,000 kits in the fall. That's about $12 million in sales for a beta product! I guess that goes to prove that advertising and sales promotion really pay. Microsoft and IBM will have had 4,000 beta testers actually paying to help them develop, debug, and tune the product.

Microsoft began shipping copies of its Presentation Manager specifications to software developers in mid-August. It is a three-volume set weighing eight pounds! No word as yet on when Microsoft plans to ship the product.

PS/2 News

As reported in the last issue, overall sales of the PS/2 Models 30, 50, and 60 have been lackluster so far although corporate acceptance seems promising. Many dealers are overstocked and offering discounts. Although the typical discounts have been in the order of 30 percent, discounts as great as 35 percent have been advertised.

Sales are expected to pick up with the release of the OS/2 operating system, the availability of more Micro Channel plug-in boards, and the introduction of application software that takes advantage of the PS/2's Micro Channel. However, by then many clone makers will be offering high-performance AT-compatibles and 80386-based systems with many PS/2-compatible features (e.g. 1.44 Mbyte 3½-inch floppy disk drives, VGA display controller) and running OS/2.

PS/2 Clone News

IBM is offering a license to PC clone makers for the PS/2 utility patents. This license would allow manufacturers to provide the same functional features as the PS/2 systems, but would not provide copies of the design technology (such as chip design, microcode, and so on). In other words, IBM will not license its hardware-design patents, copyrights, and trademarks for the Micro Channel.

Reports are that IBM is asking for royalty payments of one to three percent. The one percent royalty would be on all cloned products (PC, XT, AT, and PS/2 with retroactive payments), while the three percent royalty would apply to cloners who wish only to license selected products. IBM has reportedly had licensing discussions with several Taiwanese and Korean manufacturers, as well as U.S. and Japanese firms.

In the meantime, **Chips and Technologies** is already sampling a chip set for the PS/2 Model 30 and is promising samples of chip sets for the Models 50/60 and Model 80 by year end.

Paradise Systems is already shipping production quantities of a VGA chip to OEMs. It appears likely that this chip will appear on plug-in cards for PC/XT/AT systems and on new 286 and 386 system boards. These products are expected to be shown at Comdex in late November.

In an effort to avoid legal suits, PC clone makers are expected to implement the non-patented features of IBM's PS/2 (VGA, 3½-inch disks, OS/2) on high-speed AT-compatibles before turning to IBM's costly licensing and expensive development of Micro Channel emulation. It seems unlikely that clone makers will begin shipping Micro Channel compatibles until early '89. When they do ship, these systems should offer enhancements over IBM's PS/2 Micro Channel machines.

Cloners (such as Compaq, Tandy, Zenith, PC's Limited, and so on) are currently enjoying very strong sales of enhanced high-speed AT compatibles. Industry sources indicate that these companies are well along in developing Micro Channel-compatible prototypes. However, strong sales of enhanced ATs are expected to continue well into 1988, giving clone companies plenty of time to evaluate their PS/2 compatible system plans.

RISC on the PC

No sooner did Sun Microsystems introduce its new top-of-the-line Sun-4 series of RISC-based 10-Mips machines, which claim performance equal to a VAX 8800 system, than **Definicon Systems** (Newbury Park, Calif.) introduced a coprocessor board for the PC using the same chip set. Definicon was able to do this because the chip set was developed jointly by Sun and Fujitsu, with Sun offering licensing of the chip set, operating system, and software development tools to others. The Definicon coprocessor board will run under DOS using the PC for all I/O. This will bring a new level of performance to the PC for applications such as CAD, which sorely needs it. §

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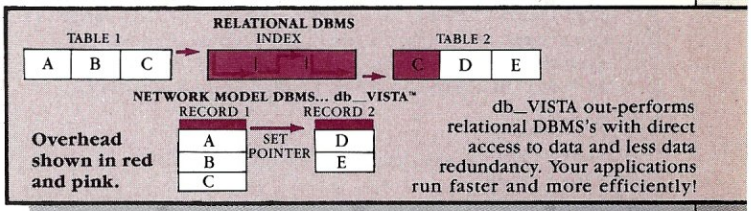

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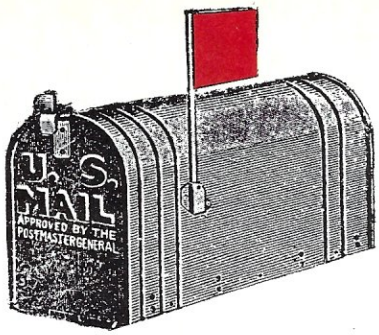

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Ask Questions and Get Resonses in Batch File Modifications

Dear *M/SJ*:

I found Bill Roger's program ("Asking Questions and Getting Responses in an MS-DOS Batch File," *M/SJ*, May/June 1987, pp. 62–64) useful and ingenious. My thanks to him for sharing it, and to you for printing it. Because I am currently using Mix C (Version 2.5.2), I had to make some changes to the program.

I also removed as many nonstandard usages as possible. Unfortunately, unbuffered keyboard input and visual display output could not be accomplished without resorting to nonstandard calls (see highlighted comments in Listing 1).

The most substantive change was replacing the line referring to the function *strchr* (bottom of page 63) with a *for* statement. Apparently *strchr* is a nonstandard function, and is not supplied with all C compilers. I also tightened the code, changed variable names, enhanced the commenting, and made other aesthetic adjustments. (See Listing 1.)

Sidney L. Sanders
Genesee NY

Listing 1

```
BATch INTERaction allows an MS-DOS batchfile to prompt the
user for a single character, and to choose its next action
based on user's response. It sets the ERRORLEVEL according
to response given by the user; and takes advantage of the
batch facility's ability to take alternate actions based on
the ERRORLEVEL's value.

To use, command line BATINTER arg1 arg2...argN is placed in
a batchfile, where:

    arg1 is an optional string of characters taken as a table
    of valid single-character responses from user. If omit-
    ted, 0123456789 is assumed. Maximum table size is 80
    characters. arg2...argN are optional strings compris-
    ing prompt to be displayed when program is ready for
    single-character response. If omitted, Character ? is
    assumed. Maximum length of prompt is 80 characters.

Examples:

BATINTER ZQPD (Z)eke, (Q)uinn, (P)at, or (D)an?
BATINTER JBLMRX
BATINTER

In the second example, default prompt will be used, and in
the third example, the default table and default prompt
will be in effect. When BATINTER runs, it displays the
prompt and waits for the user to type a single character that
matches a character in the table. When it receives a match-
ing character, BATINTER immediately sets the ERRORLEVEL
equal to off set of matching response in the table and termi-
nates. In the first example above, BATINTER would wait for a
Z, Q, P, or D. If the user types Z, the ERRORLEVEL would be
set to 0. If Q is typed, ERRORLEVEL will be set to 1, and so
on. In a batchfile, the sequence

:
BATINTER arg1 arg2...argN
IF ERRORLEVEL n GOTO a
IF ERRORLEVEL n-1 GOTO b
IF ERRORLEVEL n-2 GOTO c :

will cause the next action taken in batchfile to be deter-
mined by the user's response to BATINTER's prompt. Note
that successive tests of ERRORLEVEL should be from highest
to lowest, because expression ERRORLEVEL k evaluates to
TRUE if value of ERRORLEVEL is equal to or greater than k.
```

```
  #include (stdio.h)
  int   errlev=-1; /* ERRORLEVEL returned to MS-DOS */
  int   index; /* Index for accessing array elements */
  char  dfprompt[]="Character? "; /* Default prompt */
  char  dfrsptab[]="0123456789"; /* Default response table */
  char  resp; /* Single-char response from user */
  char  *matchptr; /* Pointer to matching char in response
  table */
  char  prompt[81]; /* Prompt string */
  char  rsptab[81]; /* Response table */

  main(argc,argv)
  int argc;
  char *argv[];
{ /* Begin main */
if(argc(2)
  strcpy(rsptab,dfrsptab); /* Default table */
else
  strcpy(rsptab,argv[1]); /* User-supplied table */
if(argc)2)
  for (index=2;index(argc;index++){ /* User-supplied prompt
*/
    strcat(prompt,argv[index]);
    strcat (prompt," ");}
else
  strcpy(prompt,dfprompt); /* Default prompt */
printf("%s ",prompt);
while(errlev(0){ /* Find char in table that matches response
*/
  printf("\b \b"); /* Erase unmatched response */
  resp=getch(); /* NONSTANDARD unbuffered keyboard read */
  putch(resp); /* NONSTANDARD unbuffered vdu out */
  for(matchptr=rsptab;*matchptr!=resp&&*matchptr!='\
0';matchptr++);
  if(*matchptr!='\0')                /* If matchptr isn't
pointing */
    errlev=(int)(matchptr-rsptab);} /* to a NUL, it's point-
ing to */
printf("\n");                        /* a matching char in
rsptab */
exit(errlev); /* set ERRORLEVEL and exit */
} /* End main */
```

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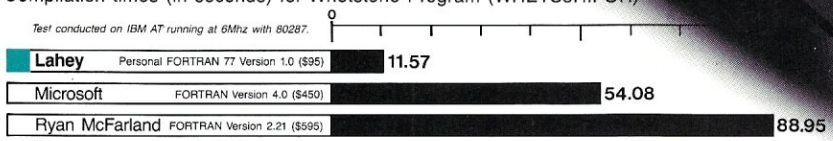

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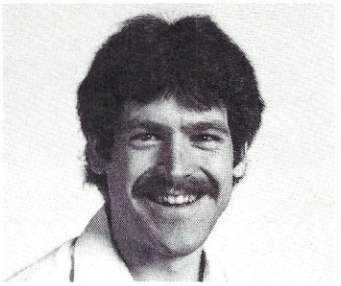


varargs —Varying Arguments

This column features tips and techniques for using the C language productively. It discusses typical problems with using C and their solutions. Reader suggestions, comments, and questions are encouraged. Address them to "The C Forum," Micro/Systems Journal, *Box 1192, Mountainside, NJ 07092.*

"varargs" is the name of a package that allows one to write portable code that passes varying numbers and types of arguments to a function.

C, of course, already lets you pass arbitrary parameters, in spite of how you may have them declared. (It's not a bug, it's a feature!) However, doing it portably is difficult because bypassing the C parameter mechanism requires understanding and handling of each machine's architecture.

Some implementations push parameters on the stack going down. Some do it going up. Depending on the type of parameter, a different amount of space may be pushed. Some systems do not even use a stack but pass all parameters through registers. And some machines use a combination of both stack and registers.

Because of this variety of implementations, there is no standard way, for example, to figure out how many arguments have been passed. Popular conventions for doing so include: (1) passing the number of arguments as the first argument, (2) terminating the argument list with a special value, such as NULL, or (3) providing a way of indirectly deducing the number of arguments (for example, by counting the %s in a *printf( )* format).

C's approach to parameter types is no different than the way it handles the number of parameters. The compiler simply doesn't check that they match between caller and callee. No information is passed as to what types the calling subroutine used. If you don't use *lint*, you are on your own.

Compiler writers would have you believe that efficiency is the reason why you can't find out how many arguments you've been passed. However, many languages do support this. For example, some provide a system variable that contains the number of arguments used to call the current procedure.

Certainly, stronger type checking in the original design would have helped immensely. For example, Ada and C++ handle much of the support for function overloading at compile-time. Whatever the reason for this lack, however, we must live with the result.

Using varargs

varargs provides a portable means of writing and calling functions with varying arguments. It was designed by Andrew Koenig of Bell Labs and has been implemented for most implementations of C.

As you will see, the syntax of varargs is unusual. It allows us to access parameters in unorthodox ways. By hiding it with macros, we gain the ability to handle variable arguments on any sensible architecture and C compiler, and to do so in a portable manner. (There are machines for which varargs cannot be implemented, but then C doesn't work very well on such machines either.)

Portable printf( )

printf( ) is a classic example of a routine that cannot be correctly declared in C. The problem is that we don't know the types and number of all the arguments at compile-time. Most implementations of *printf( )* use nonportable mechanisms for reading the arguments, often doing it in assembler. It can, however, be written portably in C. A skeleton *printf( )* is shown in Listing 1.

varargs.h is a header file that defines the macros necessary to use varargs. This is called *stdarg.h* in the current X3J11 draft C standard.

The comment */*VARARGS*/* is a directive to *lint*. *Lint* will turn off argument type checking for the following function.

All varargs subroutines take only one argument, *va_alist*. The declaration for *va_alist* is *va_dcl* (without a semicolon). If you already know some of the argument types, do not declare them. You must get them through the varargs package, anyway.

va_list arg declares an object that will point into the argument list. We can step *arg* to the next argument in the list or move it back to the beginning of the list and start over. You can use any name—it doesn't have to be *arg*. You can also declare multiple objects that can point to different places in the argument list.

To initialize *arg* to the beginning of the argument list, say *va_start(arg)*. *va_end(arg)* should be called at the end of processing the argument list, whether or not you want to reread it with *va_start( )*.

To read the next argument, call *va_arg( )*. The first parameter is an object of type *va_list*. The second parameter should be the type of the expected object after the parameter casting rules have been applied. Thus, to read an integer, we use *va_arg(arg,int)*. To read a *float*, we use *va_arg(arg,double)* since *float*s are promoted to *double*s in function calls.

In our *printf( )*, we get the format by calling *va_arg(arg,char *)* since it is a string. *next_type( )* (which is left to the reader as an exercise) returns the formatting type of the next argument. From this we can infer the type of the argument.

The Future of varargs

It is possible to support varargs without having to worry about the automatic promotion problems. One solution is to have a C operator, *promote( )*, that takes a type and returns the type after parameter promotion. However, *promote( )* requires compiler support, and it is not in the ANSI X3J11 draft C standard as of this date.

varargs is called stdarg in the X3J11 draft C standard. It originally appeared in AT&T and Berkeley versions of UNIX but

is now available in most C compilers. It is certainly easy enough to support, and if you don't have it, you should ask your C compiler vendor for it, or try writing it yourself.

It is likely that the final C standard will look slightly different from the mechanism described here. However, any changes should be minor syntactic differences.

A Related Problem—dprintf( )

Suppose we already have *printf( )*, but we would like to write a function that uses it underneath. I have in mind a function that I call *dprintf( ). dprintf( )* takes all the same parameters as *printf( )*, with one addition. This extra parameter is compared against a global *int*. If the parameter is larger than the global, *printf( )* is called, otherwise nothing happens.

This function is especially useful for controlling diagnostics. If I want a lot of debugging information, I set *global_error_level* to 10. Lower numbers print out less information. And if I don't want any debugging information, I set it to 0 so that none of the *dprintf( )*s output anything.

By passing the debug level as an argument to the program, I don't have to recompile the program in order to turn on any level of diagnostics. This code appears in Listing 2.

Actually, this was my second attempt. My first attempt never made it past *cc* because I could not figure out how to declare *args*. No matter how I declared it (*char, int, char* *, and so on) or passed it (*args, &args, *args*), *printf( )* never saw the second argument. What it did see was a lot of "stack junk." The problem was that *dprintf( )* got the stack with a good list of arguments, but all that I could pass to *print( )* was the address of my stack. I couldn't pass the stack itself!

My second version has the arguments stated explicitly. It, however, also has problems. First of all, I have arbitrarily limited myself to four arguments. No matter what number I pick, there is always the possibility that it will be exceeded. The second problem is that I have declared every argument as an *int*. This actually worked pretty well since *chars* are always converted to *ints*, and pointers (the other thing that I print out frequently while debugging) fit into *int*s on my machine. Nonetheless, I could not print out *double*s because they didn't fit into *int*s, so I always got the wrong answer. I didn't want to declare all the arguments as *double*s either, because then the *int*s would not be handled correctly.

Although it might appear that varargs could be useful here, it doesn't completely solve the problem. varargs still requires that you determine the types of the arguments. I just wanted to pass everything on to *printf( )* uninterpreted.

vprintf( ) and Friends

The solution to the problem is to use a set of routines that are defined to take *varargs*-style parameters as their arguments. These were also written by Koenig (who evidently did a lot of struggling with these same problems). *vprintf( )* is similar to *printf( )*. Both have a *(char *)* format as the first argument. However, instead of an optional list of untyped arguments such as *printf( ), vprintf( )* has a second argument declared to be of type *va_alist*.

Does this look familiar? Yes, it is the same *va_alist* from the varargs package! Now we can correctly rewrite *dprintf( )* as shown in Listing 3.

Just as with *printf( )*, there are two other varieties of *vprintf( )*. They are, naturally, *vsprintf( )* and *vfprintf( )* (Listing 4).

Like with *printf( )* and *fprintf( ), vprintf( )* and *vfprintf( )* return the number of characters output, while *sprintf( )* and *vsprintf( )* return a pointer to the beginning of the output buffer.

Conclusion

Passing varying argument may seem distasteful at first, but this is probably because it was not originally possible to do so portably. Nonetheless, it is a legacy of C. And done correctly, elegant functions such as *printf( )* are possible.

Using varargs, it is always possible to write portable code. The only pitfall you must be aware of is vararg's use of C's rules on promotion of formal parameters. Otherwise, varargs is a delight to use. varargs is already available in most C compilers, and it (or something very much like it) will definitely be in the ANSI C standard. §

Don Libes is a computer scientist working in the Washington, D.C. area. He works on artificial intelligence in robot control systems.

Listing 1

```
#include <varargs.h>

/*VARARGS*/
printf(va_alist)
va_dcl/* No semicolon! */
{
        va_list arg;
        char t, *fmt;

        va_start(arg);
        fmt = va_arg(arg,char *);
        while (t = next_type(fmt)) {
                switch (t) {
                case 'c': /* character */
                        print_character(va_arg(arg,int));
                        break;
                case 'd': /* integer */
                        print_integer(va_arg(arg,int));
                        break;
                case 's': /* string */
                        print_string(va_arg(arg,char *));
                        break;
                case 'f': /* float */
                        print_float(va_arg(arg,double));
                        break;
                . . .
        }
        va_end(arg);
}
```

Listing 2

```
dprintf(error_level,fmt,arg0,arg1,arg2,arg3,arg4)
int error_level;
char *fmt;
int arg0,arg1,arg2,arg3,arg4;
{
        if (global_error_level >= error_level)
                printf(fmt,arg0,arg1,arg2,arg3,arg4);
}
```

Listing 3

```
/*  really dprintf(error_level,fmt,args...) */
dprintf(va_alist)
va_dcl
{
        int error_level;
        char *fmt;
        va_list args;

        va_start(args);
        error_level = va_arg(args,int);
        fmt = va_arg(args,char *);
        if (global_error_level >= error_level)
                vprintf(fmt,args);
        va_end(args);
}
```

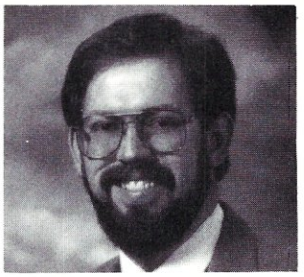
Listing 4

```
char *vsprintf(s,fmt,args)
char *s, *fmt;
va_list args;

int vfprintf(stream,fmt,args)
FILE *stream;
char *fmt;
va_list args;
```

Turbo Pascal Corner

Stephen R. Davis



VAR Variables

I am sad to report that I have been caught in a lie. Sometimes you believe so strongly that something must be a certain way that it never occurs to you to check it out. Fortunately, I caught myself this time so that I can come clean before any of you embarrass me. But first to the Turbo Pascal product news.

I have yet to hear anything about the next version of Turbo Pascal, the one with the user interface found in the newer Borland languages. I doubt that much effort is being expended in this direction considering the amount of programmer's time going into the "Great Language Wars of 1987." This, you may know, is the confrontation being waged between Borland and Microsoft. It started last year with the Campaign of the BASICs (Turbo BASIC versus Quick BASIC).

Last summer, a second front was opened at C (Turbo C versus the soon to be introduced Quick C). Although good for programming in general, these crusades direct attention away from Turbo Pascal. This, in turn, makes it unlikely that a new version of Pascal will be introduced any time soon. (Now if Microsoft would just introduce Quick Pascal and turn this into a three front war!) In any case, I will relay any military intelligence on the topic as I intercept it.

Turbo Optimizer

After my last review I felt that if I reported on another product from the people at Turbo Power Software someone was going to accuse me of being on their payroll. However, here I go again.

Turbo Optimizer is a collection of three programs: Turbo Library Compactor (TLC), Turbo Object Optimizer (TOO), and Turbo Object Librarian (TOL). TOL is a librarian that allows the programmer to store commonly used code segments in such a way that they can be called up and inserted into new programs without being recompiled. Since Turbo Pascal is so fast at compilations, this one did not excite me particularly, but the other two did indeed catch my attention.

The Turbo Object Optimizer (TOO) is an execution optimizer for Turbo Pascal. Turbo is well known for its compilation speed but not for the quality of the object code generated. Although it is not bad, Turbo-generated machine code is not comparable to the code from a good optimizing compiler. TOO accepts as input the .COM file that Turbo Pascal generates and attempts to improve it. TOO's job is complicated by the fact that it does not have access to the source code, as an optimizing compiler normally would.

The Turbo Library Compactor (TLC) attempts to reduce the size of .COM files generated by Turbo Pascal by removing sections of "dead" code that no one calls. As noted in an earlier column, Turbo Pascal saddles each .COM file it generates with the entire 10K of Turbo library—whether the file uses any of it or not. We saw that users could avoid having the library included by building a chain utility and creating .CHN files rather than .COM files; however, the TLC makes this trick less necessary because it automatically removes the majority of this library from small programs. It can also remove any user procedures that are not invoked anywhere.

In practice, both the TOO and the TLC made a noticeable improvement. The TOO can increase speed by as much as 30 percent, although 20 percent is about average. Not much to get excited about perhaps, but this is a 20 percent increase in speed with basically *no effort*. The TLC reduces .COM programs an average of 8K. For typical, rather small Turbo programs this can represent a respectable decrease. Both TOO and TLC can be applied to the same .COM for a double savings.

A special "tiny" mode can reduce specially written programs even further than that—some very small programs to as little as 100 bytes! This can be very useful indeed when using Turbo Pascal to build terminate-and-stay-resident programs such as those described in *M/SJ*, July/August 1985.

TOO works only with programs generated by PC-DOS Turbo Pascal, Versions 3.00 and later. It requires a PC, XT, AT, or a compatible, and 256K of memory. Source code is available at extra charge. Order lines are open seven days a week at (800) 538-8157 (or, in California, [800] 672-3470) ext. 830. Cost is $75 from the company, but I have seen it for as low as $65 from mail-order sources such as the Programmer's Connection.

VAR Variables

The lie I mentioned above has to do with how Turbo Pascal passes arrays as arguments to subroutines. First a little background. There are two ways to pass a parameter to a function: by value or by reference. When passing by value, a copy of the parameter is passed to the subroutine. For example, assume the variable X contains the value 10. If X is passed by value, then the value 10 is passed to the subroutine. The subroutine does not have access to the original 10, but to a copy of it. When passing by reference, the original parameter is passed to the subroutine—no copy is made. In our example, the subroutine gains access to the original 10 by passing the address of X.

Pascal allows the user to specify whether passing is to be done by reference or value. In the absence of any indication to the contrary, Pascal passes by value; however, the programmer may override this by tacking the keyword VAR to the beginning of the parameter name, as in:

```
Procedure Test (a : integer;
          VAR b : integer);
```

In this case, the variable *a* is passed by value, whereas the variable *b* is passed by reference.

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The difference is important. Variables passed by value and modified in a subroutine will retain their old values when the program returns to the calling procedure. Variables passed by reference and modified will "stay modified" in the calling routine.

Which technique is better depends on the application. Passing by reference is more flexible since it allows the procedure to "return" multiple values by storing them into the parameters. Passing by value eliminates the chance for side effects in subroutines that change the values of these parameters unexpectedly. However, there is a big problem with passing by value: How does one pass an array by value?

If performance means anything to you at all, always pass arrays of any size by reference by using the VAR prefix in front of their declarations in Procedure definitions.

To pass an array by reference, the program merely passes the address of the array, just as with a simple variable. The subroutine can use this address to access the entire array. No matter how large the array, the size of its address is always the same. To pass an array by value, however, the program must copy the entire array onto the program stack to be passed over to the subroutine. If the array is large, this wil' use up a large amount of stack space and a great deal of time will be spent copying values around. For example, passing an array X declared ARRAY [1 . . 1000] OF INTEGER would involve passing 2000 bytes (2 bytes per integer) to the subroutine.

Of course, there is an easy way out of this problem: Pass simple variables by value, but pass arrays by reference, whether they are labeled VAR variables or not. This is a logical escape, and the manual for Turbo from Borland implies in several places that this is, in fact, the case with Turbo Pascal. It seemed so logical that I knowingly asserted this over and over again in this column and others. Unfortunately, it ain't so!

Listing 1. Experiment to determine how arrays are passed to procedures in Turbo Pascal

```
Program Experiment;

Type
    data = array [1..80] of integer;

Var
    b, c : data;

Procedure Change (b:data; var c:data);
Begin
    b[1] :=  11;
    c[1] :=  12;

    writeln ('inside the procedure Change');
    writeln ('b = ', b[1], '  c = ', c[1]);
    writeln;
End;
Begin
    b[1] := 1;
    c[1] :=2;

    writeln ('before the call');
    writeln ('b =  ',  b[1], '      c = ', c[1]);
    writeln;

    Change (b,  c);

    writeln ('after the call');
    writeln ('b =  ',  b[1], '      c = ', c[1]);
    writeln;
End.
```

Listing 2. Output from program experiment

```
before the call
b = 1   c = 2

inside the procedure Change
b = 11   c = 12

after the call
b = 1   c = 12
before the /
```

Examine the program in Listing 1. Notice how the arrays B and C are first initialized. They are then passed to a procedure that sets them to some new value. Upon returning, the main program prints them out to screen to see whether the change "took" or not. Now examine the output from this program in Listing 2. Since C is a VAR variable and, therefore, passed by reference, we are not surprised that the value stays changed upon returning from the procedure.

Now look at B. If it were also being passed by reference, we would expect it to stay changed, but it isn't. A quick examination of the .COM file reveals the awful truth: The entire array is copied onto the stack before the procedure is called. This apparently always happens in this situation, regardless of the size of array B. I stand corrected.

The moral to this story is: If performance means anything to you at all, *always* pass arrays of any size by reference by using the VAR prefix in front of their declarations in Procedure definitions. Not doing so will cost your program needless time and memory. §

Stephen Randy Davis is a senior systems programmer for a defense contractor in Greenville, Texas, where he programs various microprocessors. He is also working on his Masters in physics.

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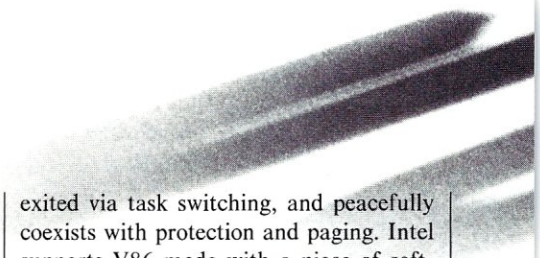
Memory Addressing on the Intel 80386

A Critical Look at the Newest Intel Processor Generation

by Howard Vigorita



When Intel announced the 8086, I recall reading that its segmentation scheme of address formation was so abstract that only systems programmers and compiler writers were likely to grasp it. Now the 80386's operating modes are causing similar confusion. Recently it has been heard that, unlike the 286, the native mode of the 386 is the protected mode. And from time to time, it is claimed that the 386 has anywhere from two different operating modes on up.

There seem to be two fundamental modes on the 386: real 386 and protected 386. The real 386 mode is a superset of the 8086, 186, and the real 286 modes of its predecessors, with some differences. If the differences are avoided, programs written for the older processors will be upwardly compatible, and the 386 can be seen as simply a faster processor with added instructions and registers.

As on the 286, the 386 comes up in real mode on reset. At the same time, the real 386 mode cannot take advantage of all the 386 features, such as 32-bit addressing, protection, paging, and hardware-assisted task switching. The only major difference between the 286 and 386 in this area is that the 386 can return to real mode from protected mode without being reset.

The 386's protected mode is characterized by 32-bit addresses and operands, as well as by the ability to provide multilevel rings of protection, virtual memory paging, and rapid task switching. The beauty of the 386's protected mode is that 32-bit operation and paging can be enabled or disabled by default in any combination. That comes to four protected mode possibilities, plus real mode, for a total of five modes.

A code segment that uses 32-bit addresses by default is called a USE32 segment in Intel terminology. When 32-bit addresses and operands are disabled by default, 16-bit addresses and operands are presumed. This code segment is called a USE16 segment, and it emulates the 286's protected mode. Although the default address and operand length can only be set together as a pair, the use of 1-byte instruction prefixes can override and reverse either of them on an individual instruction basis. That brings us up to nine modes of operation.

A variation of the 286 mode is the virtual 8086 emulation mode (V86 mode). V86 mode looks just like real 386 mode except that V86 mode can be entered and exited via task switching, and peacefully coexists with protection and paging. Intel supports V86 mode with a piece of software called the V86 monitor, which is intended to be bound to the system's 386 kernel. This monitor allows whole 8086 operating systems to run as a V86 task, with an 8086 application as a V86 subtask. Through special software hooks into the CPU, the monitor intercepts I/O and interrupts, but only engages the task gate overhead of calling the coresident 32-bit protected mode operating system when required. The V86 mode, like the real 386 mode, forms effective addresses in the same way as the 8086. With the V86 mode we now have ten modes of operation.

Effective address formation is still at the heart of the Intel scheme of things. On the 8086, effective addresses are formed by taking the value in a segment register, multiplying it by 16 (shifting it left 4 bits), and then adding the result to a pointer register. The segment register can be considered a pointer itself, albeit a pointer to memory on a 16-byte boundary (often called a paragraph).

The 286 and 386 are more unusual by an order of magnitude. In the protected mode, the segment register is no longer a pointer

to real user code or data. Instead it contains something called a "selector." Within the 16-bit selector, 13 bits constitute a record number for access to a database called a "descriptor table." The descriptor table is somewhat different from the databases familiar to most programmers. The records are all 8 bytes long, but they have a number of different formats. The code segment register selects an "executable segment descriptor," while other segment registers usually select "data segment descriptors," which may be of the "expand down" variety for optimal stack usage.

In addition, there are five types of "gate descriptors." Gate descriptors are special descriptors that, instead of pointing directly to code segments, point to other executable descriptors that, in turn, point to code segments. Gate descriptors are generally used to provide regulated, indirect access to processes of a higher privilege level, or to other tasks. A call gate is used in protected mode, for example, by far JMP and CALL instructions, which in real mode need a segment as part of the operand. The other gates are trap, interrupt, and task gates, and a collection of system segment gates.

In protected mode, the descriptor tables are where the action is. Thus in protected mode, the 386 segment registers select records from a descriptor table. A linear address is formed by fetching a 32-bit segment base address from the appropriate descriptor, and adding it to the user's pointer register. The descriptor also sets the segment size (from 1 byte to 4 gigabytes) and contains privilege information. Tests are performed to see if the intended memory reference will be permitted. The days of reading or writing to memory not allocated to you for that purpose will be gone. *That's* protection.

Once the linear address is in hand, the on-chip paging hardware translates further to a physical address. This step is optional. If paging is implemented, the linear address is broken into three parts: a 12-bit physical offset, a 10-bit page table record, and a 10-bit page directory record. Two tables are referenced: a page directory table and a page table. The page directory record is fetched and points to one of a number of page tables. The page table record is then fetched and contains a 20-bit page number as well as flags indicating whether the page has been written to (dirty bit) and is present in memory. Pages are 4K long. The final physical address is obtained by concatenating the page number (20-bits) to the physical offset (12-bits from the linear address). Pages can be swapped from disk or slower memory. Figures 1 and 2 illustrate how translation works.

Address translation is the key to physical hardware independence. It is crucial in a multitasking environment. All segment, interrupt, and I/O requests undergo descriptor and/or page translation. The operating system remaps by simply patching a translation table. Therefore, concurrently running programs will never know it when the video RAM is switched out from under them.

With all this translation and checking going on, the 64K question is: What happens to processor performance in protected mode? Considering that the 386 does no on-chip instruction or data caching in the ordinary sense, its performance is remarkable. The buffering it does do is in connection with translation tables. The segment registers are unusual in that they are actually wider than they appear. Only a 16-bit portion is visible; a hidden portion acts as a descriptor buffer. Subsequent address calculations and privilege checks consume no additional cycles. Page table records are also retained in a 32-register cache called a

"translation lookaside buffer." But there's no getting around it, instructions that access descriptor or page tables for the first time are going to take longer.

Figure 3 lists comparative cycle times for instructions that force access to a descriptor table. They are all segment-changing, I/O, or interrupt instructions. When comparing 286 and 386 instructions that purge the prefetch queue, note that the 386 fetches operands and addresses in one cycle, whether these are 8-, 16-, or 32-bits long. The 286 always fetches 1 byte per cycle.

Any other gotchas? I've already alluded to a few. 8086 or 286 code that uses the LOCK prefix may trigger an undefined opcode exception (INT 6) if used with other than a limited set of instructions. Noticeably absent from this acceptable set are the string instructions. And even when it is effective, the memory protected from coprocessor interference is now limited to the memory area defined by the destination operand of the instruction so prefixed, instead of to the entire physical address space. This need only be of concern to designers of multiprocessor systems.

Address translation is the key to physical hardware independence. It is crucial in a multitasking environment.

In V86 mode, page translation seems to be required if multiple V86 tasks are desired since descriptor translation is bypassed. The new instructions are somewhat of a problem also. Some of them overlap with the NEC V20 unique instructions.

All those protected mode 286 operating systems already out there will probably need some adjustment if they're to run as a task under a full-featured 386 kernel. The task state segment (TSS) is a structure in memory in which the processor saves its registers when multitasking. TSSs are very different on the 286 and 386—after all,

Figure 1. In protected mode, a linear address is formed by fetching a 32-bit segment base address from the appropriate descriptor and adding it to the user's pointer register.

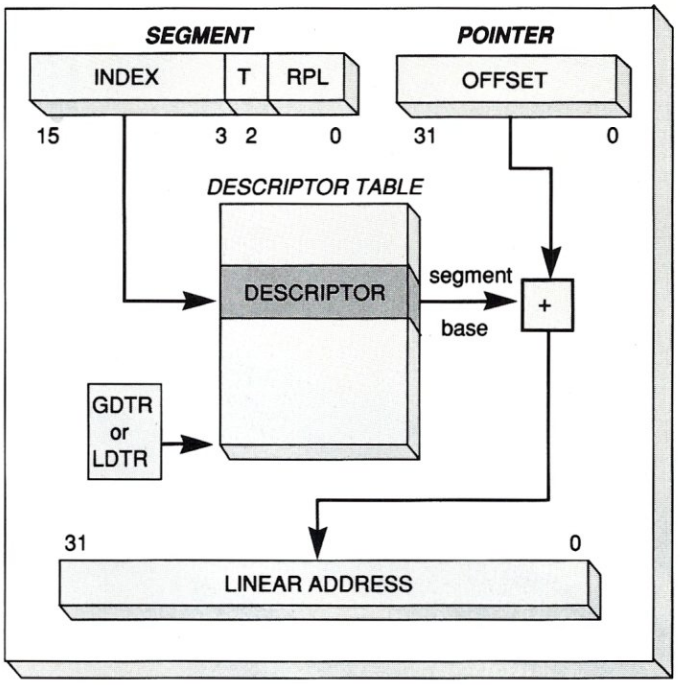


Figure 2. Once the linear address is formed, the on-chip paging hardware translates further to a physical address.

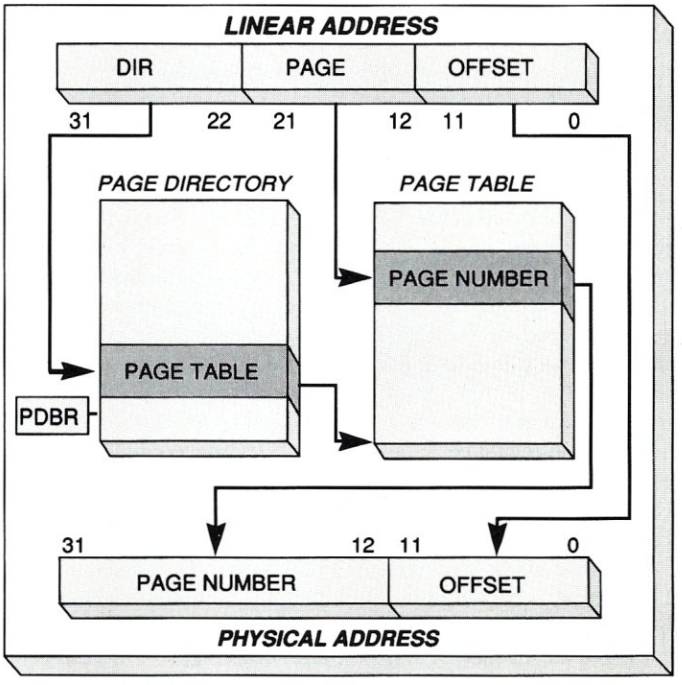


Figure 3. Here is a list of comparative cycle times for instructions that force access to a descriptor table.

	386 protected	V86 & 386 real	286 real
MOV seg,r16	18	2	2
MOV seg,mem16	19	5	5
POP seg	21	7	5
LDS	22	7	7
CALL imm32	34+m	17+m	13+n
CALL mem32	38+m	22+m	16+n
RET (far)	32+m	18+m	15+n
JMP imm32	27+m	12+m	11+n
JMP mem32	31+m	17+m	15+n
IN acc,imm	6(1) 26(2)	12	5
IN acc,DX	7(1) 27(2)	13	5
INT nn	59(3) 99(4) 316(5)	37	23+n

Notes
m = *Target instruction component count*
n = *Target instruction byte count*
1 = *I/O privilege level permits port access*
2 = *Port access intercepted or V86 mode*
3 = *Via gate to same privilege level*
4 = *Via gate to different privilege level*
5 = *V86 to 386 protected mode via task gate*

the 386 has more registers. If the 386 kernel were prevented from changing registers that the 286 suboperating system doesn't save and restore (for example, Page Directory Base Register), it would be little more than a 286 system itself. The more practical approach would be to use 386 TSSs throughout.

What enhancements would I like to see on the 486? Tops on my list would be on-chip data, code, and stack caches, as well as more data registers. And while we're at it, what about adding a Z80-styled alternate register array? There's no reason why there can't be a megabyte or two on-chip for registers and caches.

Regardless of how many modes you think the 386 has, one thing is clear. Intel is committed to upward compatibility throughout the 8086 family. With that, and its top-notch performance, the 386 has an excellent chance of achieving what has so far eluded the 8086 family: parlaying its microcomputer dominance into a stonger position in the multiuser marketplace. §

Howard Vigorita is an attorney on the staff of the United States District Court in New York and serves as vice president of the New York Amateur Computer Club.

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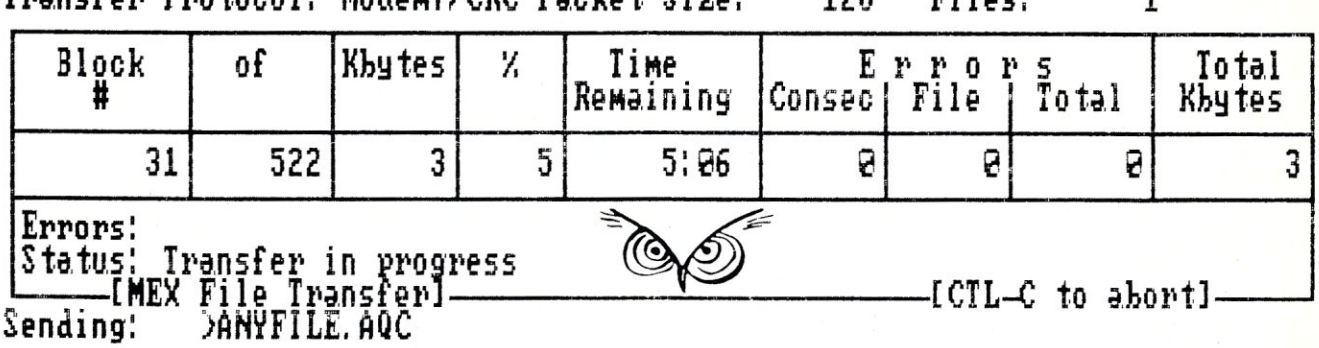

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The Micronics 80386 System Board

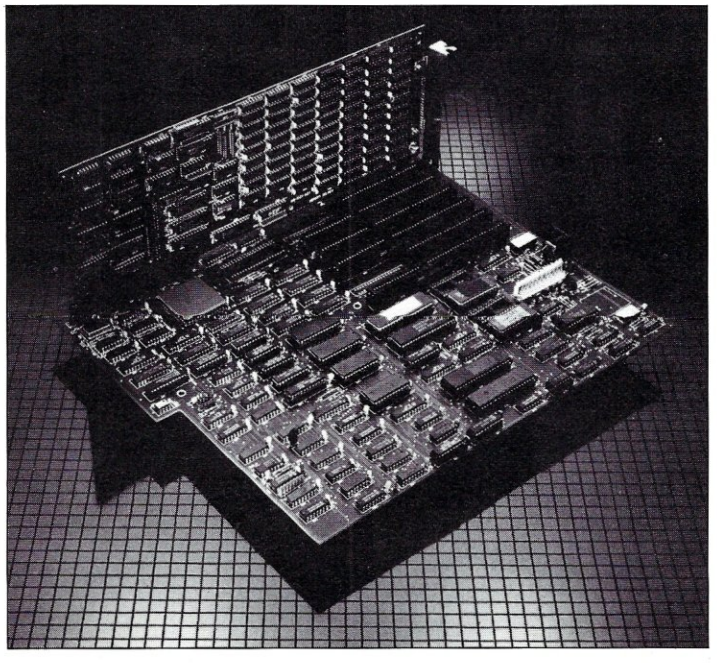
by Charles H. Strom

The Compaq 386 was the first 80386 MS-DOS-compatible computer to receive wide exposure, and the system still serves as the industry standard. Recently, I had the opportunity to acquire a system that is basically a Compaq 386 clone, an AT-form-factor system board designed and manufactured in the United States by Micronics Computers (formerly known as Four Star). Micronics initially configured complete systems, but now has gone into full-time system board production. The system reviewed here was configured by Dyna (a clone manufacturer) and is sold by Servu, although the Micronics board is available from other sources as well.

The system received for review consisted of the Micronics board with 1 Mbyte of static column RAM, a Western Digital floppy/hard-disk controller, a Seagate ST4038 hard disk, 360K and 1.2-Mbyte Toshiba floppy disk drives, and a Quimax AT-style keyboard. I added a Tseng EVA/480 display card, an additional megabyte of RAM, and an I/O board containing a parallel and two serial ports. Servu will supply the system board with 1 Mbyte of RAM for $1,595, and a complete monochrome system is available for approximately $3,400.

As in the Compaq, there is a single, 32-bit expansion connector that can accept a memory expansion board. The standard configuration has 1 Mbyte of static column chips soldered in, with sockets for another 1 Mbyte. An optional piggyback board is available for $335 that allows expansion to 4 Mbytes using 256K chips. The system can accommodate up to 10 Mbyte of RAM in its full configuration. Of course, the similarity to the Compaq cannot extend to the use of Compaq's BIOS. Micronics uses both the Phoenix and Award chips.

The 80386 System Board Recently Introduced by Micronics



The system is supplied with several utilities on disk, including a SETUP program to set the clock/calendar, configuring the drives, and so on. Also supplied is a SETSPEED utility that allows the operator to slow the system speed in several steps to that of a 4.77 MHz PC. Since the seven AT-style expansion slots run at 8 MHz, I had little reason to slow things down. The only time I did so was when I used my Irwin tape drive for backups. (This backup device is designed for the external floppy disk connector on a PC or XT, but Irwin supplies a board that plugs into an AT and allows

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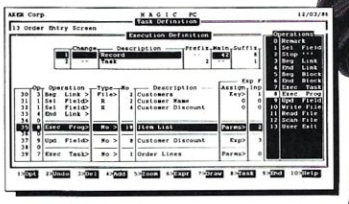

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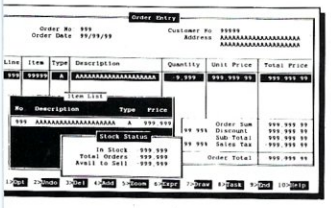

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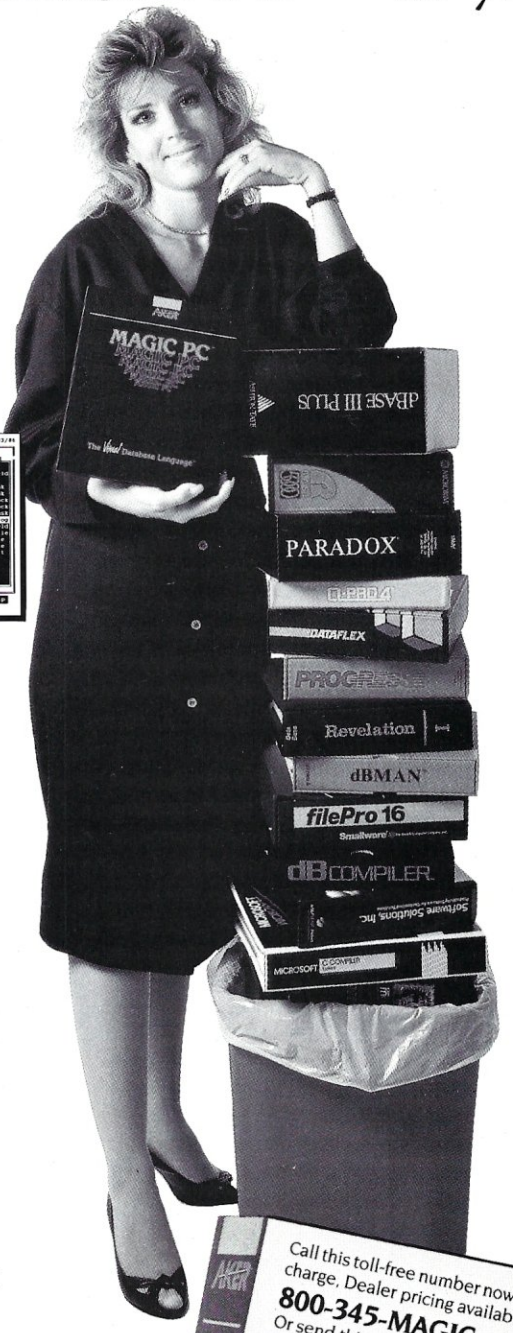

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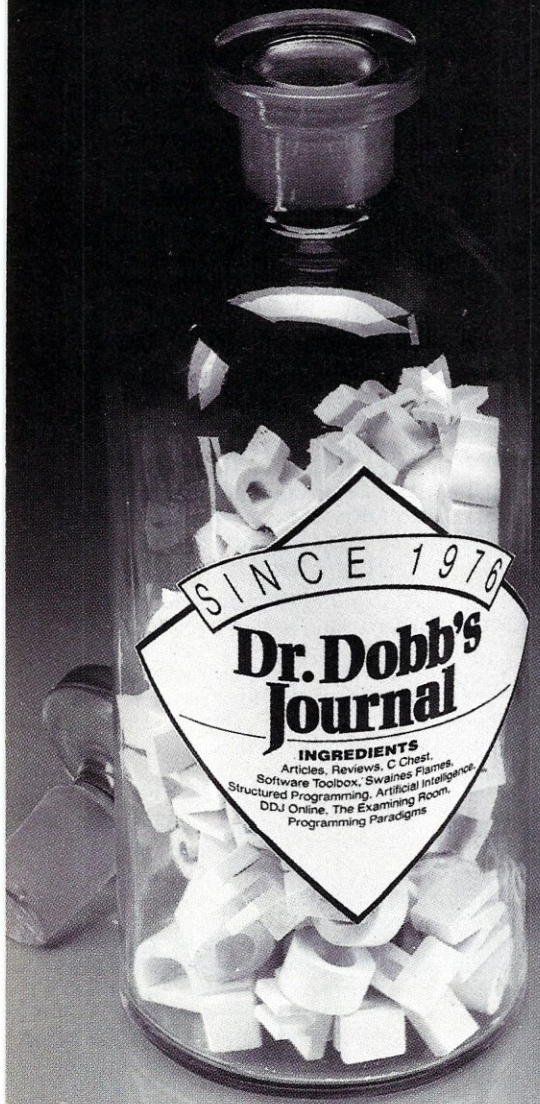

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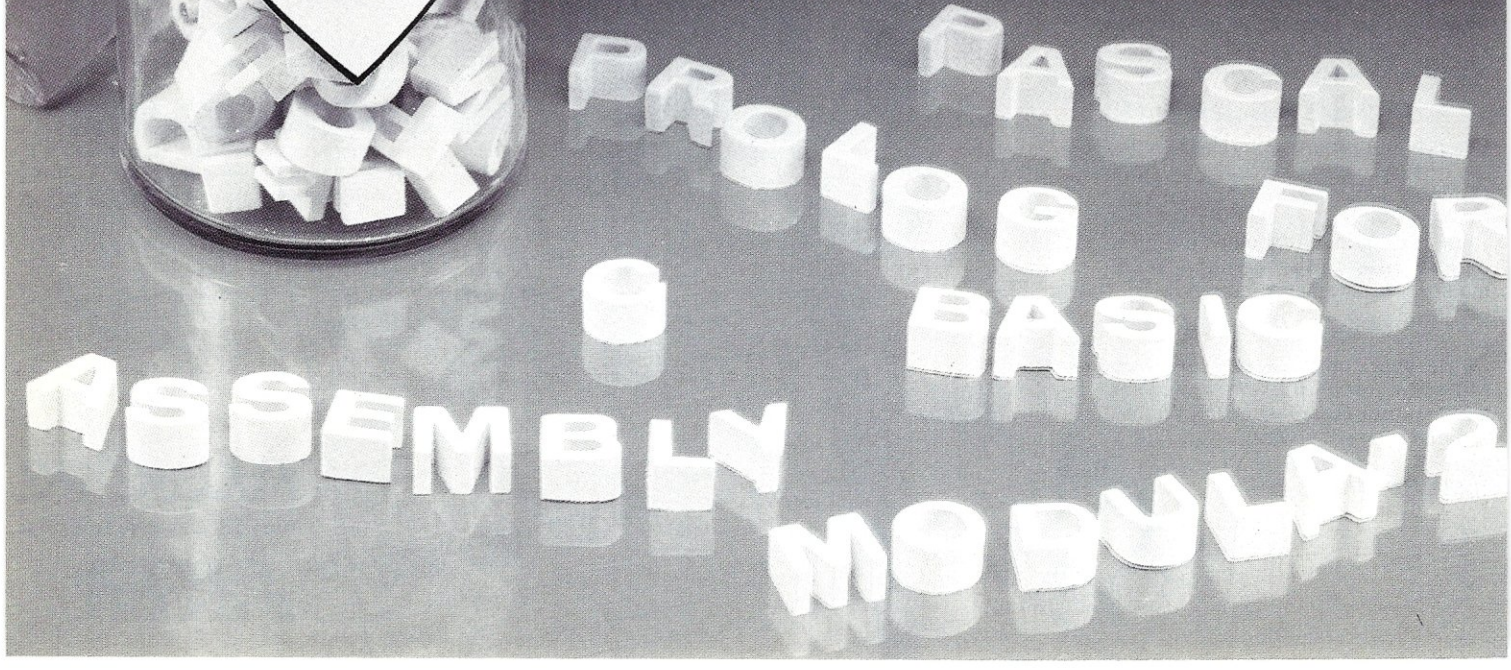

Figure 1. MIPS benchmark tests results

BENCHMARK PERFORMANCE RELATIVE TO =>	IBM/PC 4.7 MHz	IBM/AT 8 MHz	COMPAQ 386	ACTUAL MIPS
General instructions	6.79	1.97	1.00	1.12
Integer instructions	14.58	2.28	1.00	2.45
Memory to memory	5.82	1.79	1.00	1.38
Register to register	18.35	2.39	1.00	3.30
Register to memory	6.04	1.81	1.00	1.86
Overall performance	*8.44*	*2.04*	*1.00*	*2.02*

Figure 2. *PC Magazine* laboratory benchmark series

	TIME IN SECONDS	SPEED INDEX RELATIVE TO 4.77 MHz PC	SPEED INDEX RELATIVE TO 8 MHz AT
1. 128K NOP loop:	2.09	4.80	2.00
2. Do-Nothing loop:	1.86	5.30	2.00
3. Integer add loop:	0.99	10.00	2.20
4. Integer mulitply loop:	0.61	16.40	2.00
5. String sort and move:	1.32	8.00	2.20
6. Prime number sieve:	1.82	8.50	2.30
Bench21–Version 1.31: Processor speed benchmark test			

	TIME IN SECONDS	SPEED INDEX RELATIVE TO 4.77 MHz PC	SPEED INDEX RELATIVE TO 8 MHz AT
8086/8088 instruction set	4.29	7.50	2.10
Bench28–Version 1.01: Processor speed instruction mix test			

	TIME IN SECONDS	SPEED INDEX RELATIVE TO 4.77 MHz PC	SPEED INDEX RELATIVE TO 8 MHz AT
Floating point (no 80287):	22.30	7.00	1.60
Floating point (with 80287):	3.35	1.50	0.90
Bench29–Version 1.01: Floating point and math coprocessor test			

the drive to be used through its connector. When using this combination, it became necessary to slow down the clock to prevent BIOS parity error messages.)

Another useful utility is RELOCATE, which allows both BIOS and EGA BIOS code to be moved to high-speed memory. The memory map is identical to the Compaq in that the upper 384K of the first megabyte of RAM is dedicated to system use. The RELOCATE utility moves the code to this area, allowing full speed access. The speed enhancement is significant.

Lastly, Micronics includes an expanded memory driver (Lotus/Intel/Microsoft standard), functionally similar to Compaq's CEMM.SYS. This driver allows programs such as Lotus 1-2-3 to take advantage of the extra memory in order to expand the maximum size of a spreadsheet, to run the FLASH expanded memory disk cache program, and to perform other functions.

The system board has a socket for an 80287 numeric processor that can run at 4 MHz, 8 MHz, or 10 MHz, depending on switch positions (although in the last case, actual crystal replacement is necessary). I removed the 80287 from my 80286 system and had no trouble installing it in the new board. It is unfortunate that Micronics did not include a socket for the 80387, but they have just informed me that a piggyback board will shortly be released that plugs into the 386 socket. The 386 and a 387 may in turn populate the piggyback. It is also rumored that Intel may release an 80387 in a package pin-compatible with the 80287 to complement the (also rumored) 80386 in a 80286 pin-compatible package.

The balance of the hardware in the tested configuration is familiar AT-compatible technology. The disk drive is probably a little slower than the ideal for a speed demon such as this, but virtually any ST-506-compatible drive should work. Some video boards might have problems with the system because of its speed, but the Tseng used for testing operates flawlessly.

I do have one serious complaint—the designers neglected to include a hardware reset button on the system. Therefore, in order to do a hard reset (when Ctrl-Alt-Del fails), it is necessary to completely power-down the system, which is not only annoying but potentially damaging to the equipment. (Interestingly, IBM also omits the reset button on its PC and PS/2 systems.)

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ough workout is to use it every day as one's main system. In fact, I have been running a variety of software on this machine and have experienced no trouble at all. Modem programs such as Qmodem, Pro-Yam, PC-VCO and Procomm, work fine. Word processors (WordStar 4 and Microsoft Word), spreadsheets (SuperCalc 4 and Lotus 1-2-3), and utilities such as Norton and Media Master, also operate flawlessly. And, of course, all the DOS 3.2 utilities perform as they would on an AT, only much faster. In addition, there are no hardware or software problems running a parallel Epson FX-80 printer nor a Hewlett-Packard serial Laserjet printer.

80386 Software

In addition to increased speed, the best reason to purchase an 80386 system is to run 80386 software. I had the opportunity to test several such packages. Quarterdeck, the authors of DESQview, supply an expanded memory simulator similar in concept to that supplied by Micronics and Compaq. However, QEMM.SYS goes them one better by implementing a subset of the AST/Quadram/Ashton-Tate expanded memory specification. This allows DESQview 1.3 to use all the available 80386 memory for running concurrent applications. I have always been a fan of DESQview. Its ease of use (there is little need to read the manual) and multitasking capabilities are now coupled with the ability to run multiple large applications. DESQview and QEMM.SYS ran flawlessly, permitting, for example, xmodem protocol file transfers from GEnie while simultaneously running utilities in a 256K DOS window.

Another recent development in the 80386 software scene is Digital Research's Concurrent DOS 386. I will leave a discussion of the details of CDOS 386 for the review in this issue and just say that I have been running it for several weeks on the Micronics System straight out of the box with no problems whatsoever. (See page 28 for a review of Concurrent DOS 386.)

Lastly, I had the opportunity to beta test a newcomer to the operating system scene, PC-MOS/386 from The Software Link of Atlanta, Ga. PC-MOS, like CDOS 386, is a stand-alone operating system designed to replace PC-DOS. It supplies all the existing functionality of the Microsoft operating system while enhancing it with features tailored to the increased speed and memory addressing power of the 80386. It was developed on a Compaq 386 but runs satisfactorily on the Micronics system. One small glitch is that the BIOS reports a memory error on boot-up, but there is no apparent ill effect, and PC-MOS behaves properly. It is unclear at this point if there is a hardware problem, or a BIOS or software incompatibility of some sort.

Benchmarks

No review of an 80386 computer is complete without a suite of tests benchmarking speed. The Norton Sysinfo (SI) utility Version 3.10 reports that the system is equivalent to an 18.7 IBM PC. I understand that this is identical to results on the Compaq 386. MIPS, a popular benchmark program from Chips & Technologies, Inc. (available in the PC/Blue public domain software library), produced the timings shown in Figure 1.

PC Magazine has developed an exhaustive series of benchmarks and has released them into the public domain. I ran several of the CPU/memory tests from Version 4 of the series as shown in Figure 2.

The benchmark series is apparently not set up to correctly identify and deal with an 80386 microprocessor, for the last benchmark was littered with garbage characters in the locations where "80386" and "80287" should have appeared. The results, however, seem to make sense in light of the 4 MHz operation of the numeric processor as opposed to 5.33 MHz on an 8 MHz AT.

Conclusion

I am very pleased with the Micronics 80386 system. It offers the blazing speed of the new generation of compatibles at a very affordable price. The manufacturer does not appear to have cut corners in design and fabrication of the computer. I am eagerly looking forward to many happy hours investigating the new 80386 software that is just now starting to appear on the market. §

Charles H. Strom is Director of Laboratories and Associate Director of Technical Services in the Department of Chemistry at New York University.

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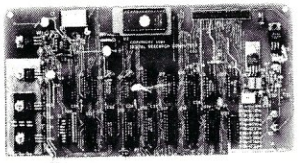

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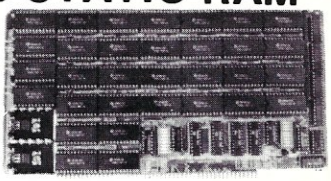

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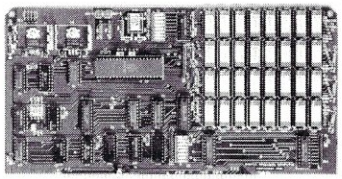

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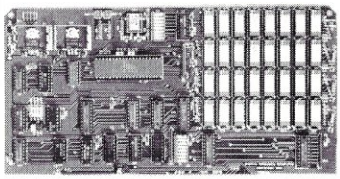

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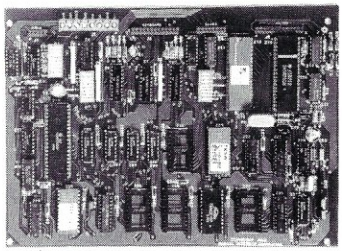

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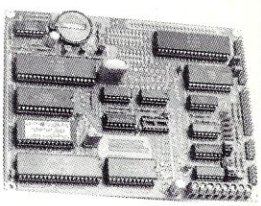

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Concurrent DOS 386

DRI's Multitasking, Multiuser 386 Operating System

by Alex K. H. Soya

The 32-bit 80386 chip from Intel has been the talk of the town among programmers and hardware designers for some time. Compaq was the first manufacturer to ship an 80386-based system (DeskPro 386), which is AT compatible. Recently, many clone manufacturers have introduced 80386 systems as part of their product line. Unfortunately, however, no software has existed to take advantage of the 80386 architecture. The 8086 PC-DOS/MS-DOS operating system can be used on the 80386, but in real mode, which means that it cannot use the advanced features for which the 80386 chip is intended. Digital Research, in the meantime, has been producing the Concurrent DOS 86 multitasking, multiuser operating system for use with the 8086 (see *MS/J*, May/June 1987) for over two years. Now, the British office of Digital Research, Inc. (DRI) has modified Concurrent DOS 86 to take advantage of the 80386 chip and has recently introduced Concurrent DOS 386, an 80386 operating system that truly uses the 80386 advanced features. DRI provided us with a copy of its new operating software and we put it through its paces.

The 80386 Chip

The Intel 80386 chip is a 32-bit microprocessor designed primarily to support multitasking, multiuser operating systems and high-level languages. Thus it offers features useful to implementing operating systems and high-level languages.

The 80386 is compatible with the earlier 8086 and 80286 processors. To remain compatible with its predecessors, the 80386 processor can run in one of several modes.

Real mode refers to the 8086-compatible mode of operation. When it is reset, the processor is placed into real mode. In this mode the 80386 looks just like the 8086 chip. As noted, the PC-DOS/MS-DOS operating system runs on 80386-based systems in real mode.

The 80386 protected mode is a superset of the 80286 protected mode functions. The additional functions include memory paging, a larger addressing space, an enhanced Task State Segment (TSS), and more sophisticated I/O privilege functions.

The most useful mode from the user's point of view is the virtual 8086 mode. In this mode the 80386 offers full compatibil-

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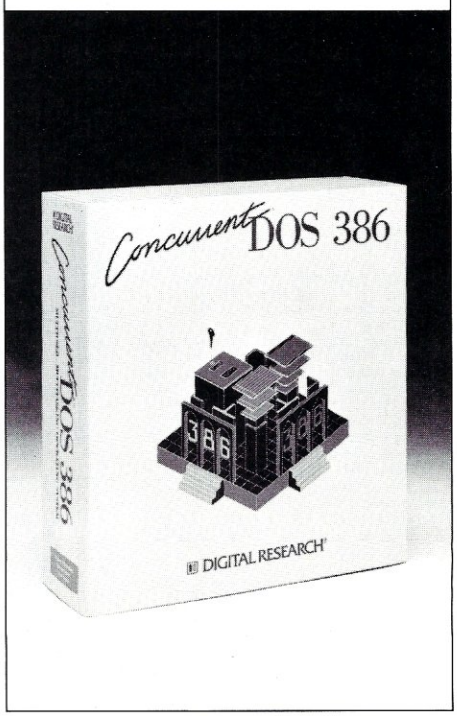

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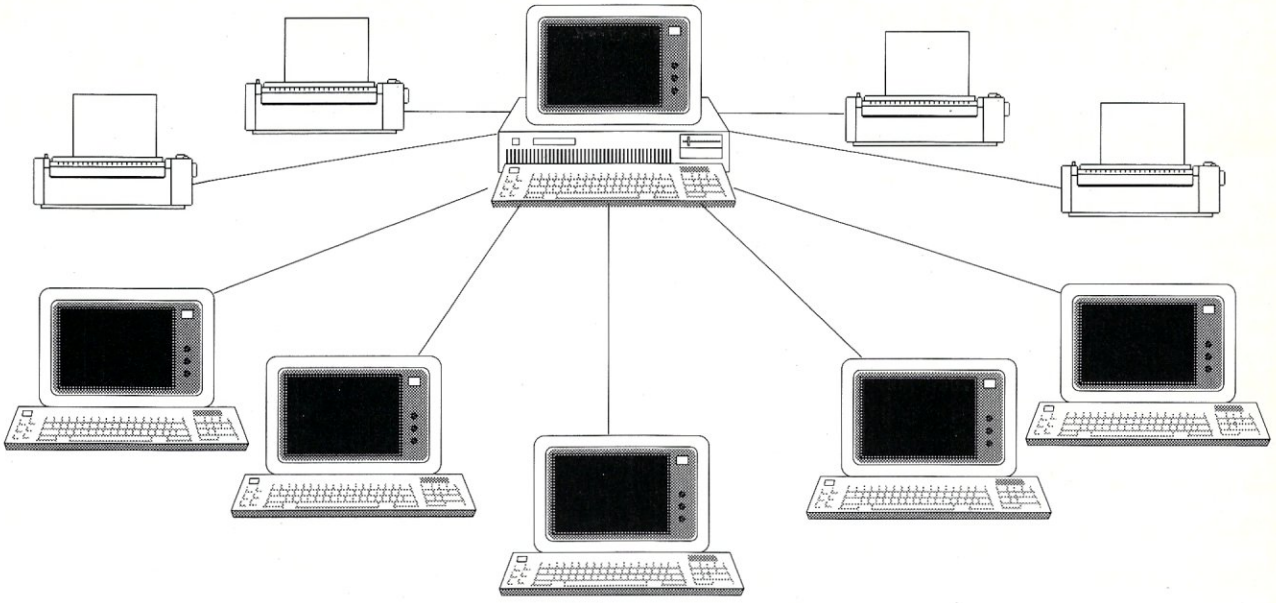

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ity to 8086 applications, while the operating system can take advantage of the 32-bit features, including the larger addressing space, paging, protection, and multitasking features.

To get a more detailed description of the 80386 and its specific features, consult the Intel 80386 programmer's guide.

Concurrent DOS 386 Installation

Concurrent DOS 386 is shipped on four 5¼-inch PC-DOS/MS-DOS formatted floppy disks. The installation procedure is simple. The user boots the system on the first disk and answers a few straightforward questions on easy-to-read menus.

The major advantage of Concurrent DOS 386 compared to the 8086 version of the operating system is its ability to take advantage of the 80386 memory management functions.

Concurrent DOS 386 allows for many custom-made options. The user may select among language, keyboard, and printers for various international versions of clones.

The supported languages are: English (American), English (British), French, German, Danish, Norwegian, Swedish, Italian, and Spanish. By selecting a particular language, the user ensures that the proper character set (with any special characters) will be loaded. Some of the prompts are displayed in the selected language.

Other items that may be selected include disk drive characteristics, color monitor scroll mode, and serial port assignments.

I installed Concurrent DOS 386 on a Compaq DeskPro 386 with a 40-Mbyte hard disk. The operating system supports both PC-DOS/MS-DOS and CP/M media type drives. At first I installed Concurrent DOS 386 to use the entire 40-Mbyte drive as a single PC-DOS/MS-DOS media partition. However, with this configuration PC-DOS/MS-DOS could no longer access the hard disk, as PC-DOS/MS-DOS limits the partition size to 32 Mbyte. I thus repartitioned the hard disk into two PC-DOS/MS-DOS partitions: 32 Mbyte as drive C and the remainder as drive D. Concurrent DOS 386 allows partition editing with its own version of FDISK.EXE.

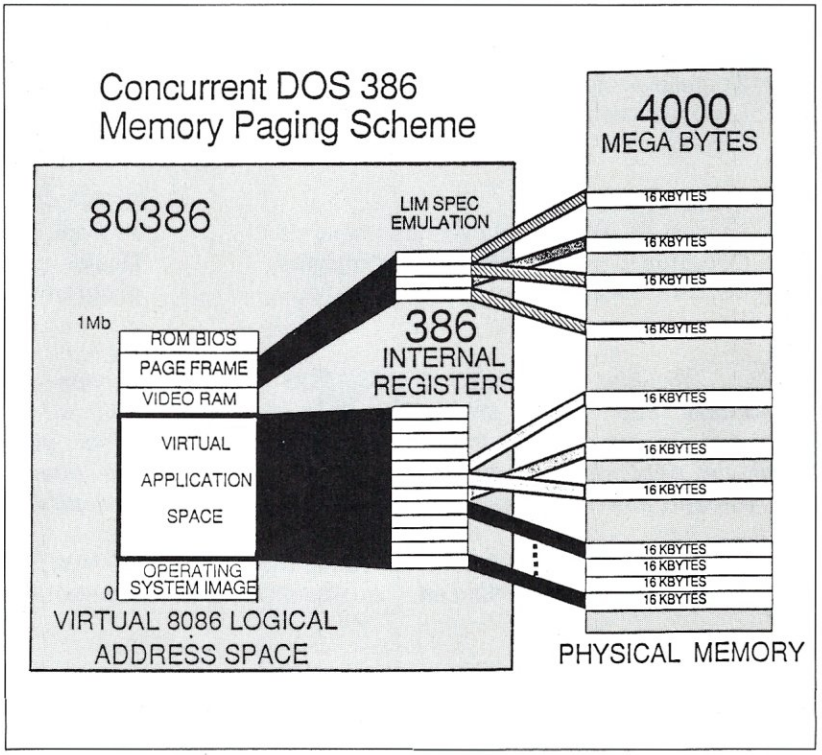
The User Interface

Concurrent DOS 386 may be booted from a floppy disk or from the hard disk. On the hard disk it is possible to boot Concurrent DOS 386 directly when the power is switched on, or after booting PC-DOS/MS-DOS by typing LOAD386. I set up my own system to boot Concurrent DOS 386 directly from the hard disk and to boot PC-DOS/MS-DOS from a floppy for those rare times when I want to run PC-DOS/MS-DOS.

The command line interface to Concurrent DOS 386 is identical to that of Concurrent DOS 86 XM. I thus felt immediately at home and did not have any difficulties in finding my way around the system. (For a detailed review of Concurrent DOS XM, refer to *MS/J*, May/June 1987.)

Concurrent DOS 386 has the same utilities as Concurrent DOS 86: FILE MANAGER, a screen-oriented file and application manipulator; CARDFILE, an electronic index card manager; DREDIX, a simple full-screen editor; WMENU, a window manager that allows window sizes, location, and colors on virtual consoles to be varied; and RUNMENU, a menu manager that allows the system manager to design fancy menus to guide the user through applications without ever having to issue a single DOS command.

Figure 1. The memory map for the application looks identical to that of the PC environment—the bottom 1 Mbyte contains the operating system image, the application memory space, video RAM, and application memory.



Let's Get Technical

Concurrent DOS 386 allows existing PC-DOS/MS-DOS applications, as well as CP/M-86 and native mode Concurrent DOS applications to run in a multitasking, multiuser environment. The major advantage of Concurrent DOS 386 compared to the 8086 version of the operating system is the way in which memory management functions are performed.

Under Concurrent DOS 86, the directly addressable memory was limited to 1 Mbyte, plus up to 8 Mbytes of paged memory conforming to the LIM/EEMS (Lotus, Intel, Microsoft/Enhanced Expanded Memory Specification). The 80386 version, however, uses 80386 memory management functions to perform paging of up to 4,000 Mbytes (or 4 gigabytes) of physical memory into the virtual application space. In reality, the amount of memory is limited by the physical restrictions of the hardware—in the case of a Compaq Deskpro 386, this is 16 Mbytes. In the near future, we should see systems that exceed this limit.

To the application, the memory map looks identical to that of the PC environment. The bottom 1 Mbyte contains the operating system image, the application memory space, video RAM, and BIOS ROMs. The remaining 3,999 Mbytes may be used as paged application memory. When Concurrent DOS 386 assigns memory to a process, it sets up a memory page descriptor that can be used by the 80386 paging registers to map any 16K chunk of physical memory to any area in the application space. When a task switch occurs, the paging registers are loaded to point to the physical memory pages belonging to the next process serviced by the CPU. Figure 1 shows a graphic representation of the paging memory mechanism.

This scheme allows several applications to run within their own 1-Mbyte addressing space. But what about applications that need more than 1 Mbyte of memory? In the PC-DOS/MS-DOS environment, such applications (for example, Symphony) use EMS memory from specially designed EMS memory cards. Concurrent DOS 386 emulates the LIM specification and thus allows applications designed to take advantage of EMS cards to work correctly under Concurrent DOS 386.

Compatibility

As there is already a wealth of software available for PC-DOS/MS-DOS and Concurrent DOS XM, it is important that Concurrent DOS 386 be able to use the existing software base. Many of the multitasking operating systems (including Microsoft's announced ADOS) will not run existing applications. Under Concurrent DOS 386 two modes of compatibility must be considered: (1) native mode Concurrent DOS applications and (2) PC-DOS/MS-DOS applications.

In Concurrent DOS native mode, applications have access to advanced operating system features. Many of these features are intended for multiuser applications and include items such as shared file access, file/record locking, interprocess communications, resource management, and many more. I tested Concurrent DOS 386 with several native mode applications including CALLME, my own remote console manager software. CALLME uses some very sophisticated techniques to make itself an extension to the operating system. I did not expect it to run under Concurrent DOS 386 without modification and thus was surprised when it did. Other Concurrent DOS applications I tested included New Word 3.1 from New Star Software (recently acquired from Micropro, which now markets the PC-DOS/MS-DOS version of New Word as Wordstar Version 4), CP/M-86 Turbo Pacal by Borland, Aztec-C by Manx Software, Spell Binder from Lexisoft,

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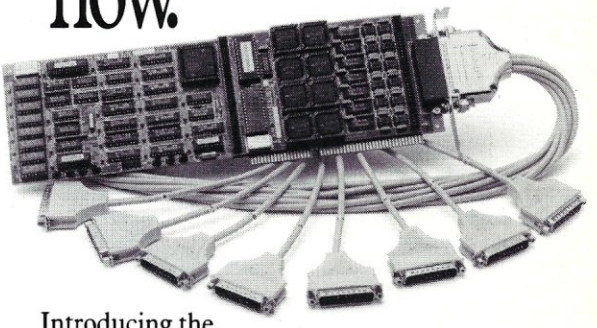

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and many public domain Concurrent DOS applications. All ran quite well. I am confident that the native mode of Concurrent DOS 386 is identical to that of its 8086 counterpart.

The PC-DOS/MS-DOS emulation under Concurrent DOS 386 seems to be even better than that of the 8086 version. On my test list were GEM, Wordstar 4.0, Supercalc 3, dBASE 2, Turbo Pascal, and a multitude of public domain and shareware applications. I had trouble with a few games that were written using timing loops rather than the system clock. These games were so fast that they were impossible to play.

PC-DOS/MS-DOS applications that give trouble in any multitasking, multiuser environment are TSRs (terminate-and-stay-resident). These applications usually attempt to overlay interrupt vectors or portions of the PC-DOS/MS-DOS operating system. In a multitasking environment, such a practice is quite dangerous. Not all TSRs, however, are doomed to failure. Well-behaved TSRs work well under Concurrent DOS.

Terminate-and-stay-resident applications may be written for the Concurrent DOS native mode by detaching a process from the console. The difference between native mode detaching and PC-DOS/MS-DOS stay-resident functions is that native mode processes can continue execution in the background. Through the use of queues and system flags, other processes may send signals to the detached process.

Even though Concurrent DOS is a multitasking, multiuser operating system, PC-DOS/MS-DOS applications are not written for a multitasking environment. It is thus not possible to get a PC-DOS/MS-DOS application to share the same files across several terminals. Only native mode Concurrent DOS applications can do this.

The version of Concurrent DOS 386 supplied for this review emulated the PC-DOS/MS-DOS version 2.1 environment. According to DRI, Concurrent DOS 6.0, which should add PC-DOS/MS-DOS 3.3 compatibility, is in development. This means that future versions of Concurrent DOS 386 will implement the PC-DOS/MS-DOS 3.3 file/record locking functions, thus allowing multiuser PC-DOS/MS-DOS applications to be used.

The 8086 version of Concurrent DOS uses the commands COMSIZE and ADDMEM to allocate memory partitions to DOS applications. Under Concurrent DOS 386 these commands still exist but behave slightly differently. By default, the entire virtual application space (between 300K and 400K, depending on configuration) is assigned to the DOS program. ADDMEM and COMSIZE are now used to reduce the amount of memory assigned to DOS applications, rather than to add memory (as is the case with the 8086 version of Concurrent DOS). As the application space is paged out during context switches, this scheme is easier to handle from the user's point of view.

Networking

Local area network (LAN) support is available under Concurrent DOS 386 through the use of the already existing DRNET 1.2 network interface software. Through DRNET, multiple Concurrent DOS–based workstations may communicate with one another. DRNET supports Arcnet, Ethernet, Token-Ring, Omninet, and, if speed is not important, even RS-232.

My personal system is based on Arcnet cards from CompuPro and Standard Microsystems. I have an 80286-based CompuPro under Concurrent DOS 5.0 with 130 Mbytes of hard disk storage, a CSS AT clone running Concurrent DOS

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5.1 XM with a 27-Mbyte hard disk, a floppy-based PC under PC-DOS/MS-DOS with CompuPro CPLINK, and the DeskPro 386 under Concurrent DOS 386 with the 40-Mbyte drive, all hooked together over the network. This gives me a total on-line storage of 200 Mbytes on any of the above systems, even the floppy-based PC.

The procedure for adding the network software to Concurrent DOS 386 is identical to that for adding it to Concurrent DOS 86. The version of DRNET used for Concurrent DOS 86 is used with Concurrent DOS 386 as well.

Setting up a network system is not a trivial task, it requires some careful planning and thought in order to allow maximum utilization of available resources. DRNET 1.2 works well in this environment. One of the major advantages of DRNET under Concurrent DOS versus PC-DOS/MS-DOS-based networks is that no special network versions of application software are needed. The network mechanism is completely transparent to the applications.

Also, each node in the network may be a server as well as a client. There is no need for a dedicated server system. It is thus possible to log in from any node into any other node.

Devices that may be mapped across the network include printers, disk drives, and queues. Through the use of mapped queues, processes can communicate with each other over the network. Thus it is feasible to use separate CPUs to work on portions of the same application. This feature is useful for multiprocessor environments.

Summary

The 80386 CPU provides many sophisticated features not possible with 8086-compatible operating systems. Concurrent DOS 386 provides a multitasking, multiuser environment with downward compatibility for applications from 8086 environments by letting these applications run in the virtual 8086 mode.

The major advantage of Concurrent DOS 386 is its ability to take advantage of the 80386 memory management functions. The multitasking, multiuser ability of Concurrent DOS 386 allows expensive resources to be shared in a cost-effective manner. Another important advantage to business users is that the operating system offers a familiar user interface; this makes training personnel already familiar with PC-DOS/MS-DOS or the 8086 version of Concurrent DOS unnecessary. §

Alex Soya is Manager of Research and Development at Concurrent Research, Inc., Satellite Beach, Florida, where he is responsible for the development of computer applications aimed at multiuser environments. He holds a degree in computer science from the Florida Institute of Technology and his interests include operating systems, data communications, system utilities, real time and scientific programming.

Product Information

Concurrent DOS 386
3-user version: $395
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Intel Inboard 386

Upgrade a PC/AT to the 80386 with a Plug-In Card

by Hank Kee

When Compaq introduced its 386 system in September of 1986, I began to think of switching to a 286-based IBM PC/AT but the price seemed a little steep. Also, having previously been burned by "advanced technology," I was concerned that critical programs might not run on the Compaq and I would be stuck with a white elephant.

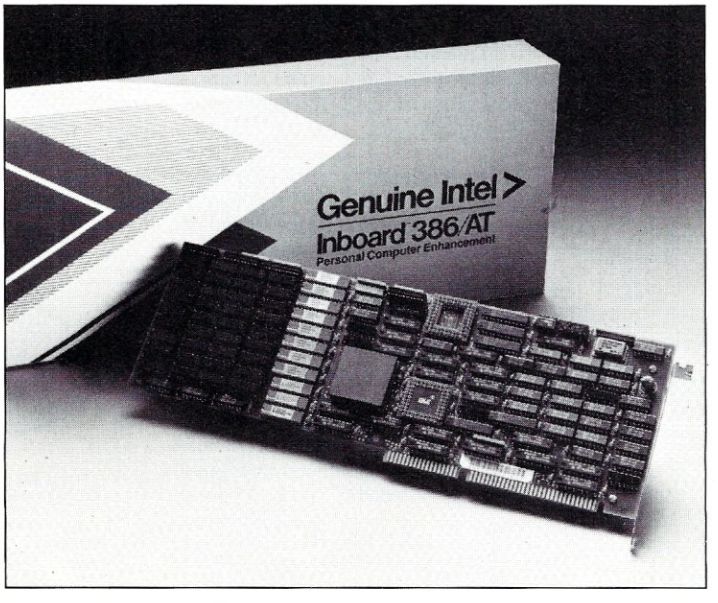
So when Intel announced the Inboard 386, a plug-in 386 processor board for the IBM PC/AT, it aroused my interest. I could upgrade rather than scrap my current system, and if any programs would not run, I could just remove the Inboard, converting the system back to its previous capabilities.

The Intel Inboard 386 is a full-length plug-in accelerator card for converting an IBM PC/AT from a 16-bit 80286-based system into a 32-bit 80386-based system. It also adds some functional features. Not only does it boost the processing speed of the AT, but it runs the new multiprocessing/multiuser 32-bit software now coming to the market for 386-based systems.

But could a modified AT dressed up with a different processor offer real advantages? The objective of this review was to try to answer the following questions:

- Was compatibility maintained for a system containing interconnect boards such as 3278 emulators, Token-Ring adapters, and Ethernet links?
- Is this a real 32-bit system, or is it a warmed-over 16-bit system?
- What software can take advantage of such a system?

Intel's Inboard 386, a plug-in processor board to upgrade the IBM PC/AT



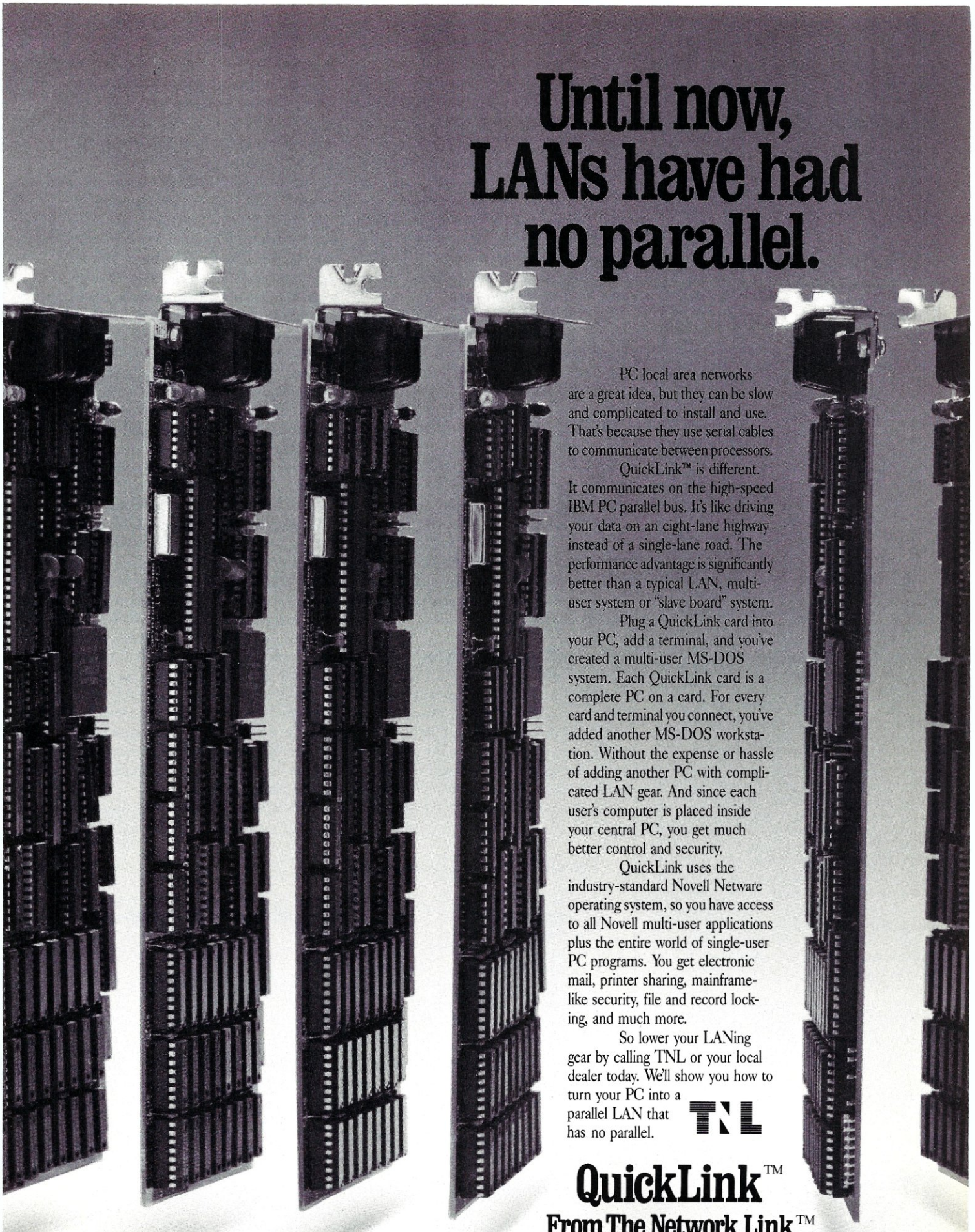
Benchmarking the Inboard

Intel provided me with one of its early production Inboard 386 cards. The first thing I did was run some of the standard speed benchmark tests used to evaluate XT- and AT-compatible systems. The tests I ran were the CPU2, Landmark, and MIPS tests, all of which are in the PC/Blue and some other public domain software libraries. I was also able to run the tests on the Compaq 386 system that was available. The results indicate that an IBM PC/AT equipped with the Intel Inboard 386 is comparable in performance to a Compaq 386, if not slightly better (Figures 1 and 2).

Installation

Installing the Inboard 386 is not difficult, but it can be a bit perplexing. First, the 80286 processor chip has to be removed from the AT motherboard. A connecting ribbon cable containing a logic circuit is then installed from the original 80286 socket to the Inboard card.

The interconnecting cable provided with the Inboard is designed specifically for systems that are physically and electrically compatible with the IBM PC/AT. Some AT-



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compatible systems use a different 286 chip package and will require a different interconnecting cable. The Sperry Micro IT, AST AT, and the Compaq 286, for example, all require the nonstandard LCC cable (also available from Intel). Also, some so-called AT compatibles do not have removable 286 processor chips or have different bus structures (such as the AT&T 6300+) and hence cannot be converted. It is advisable to check with Intel if you are unsure about system compatibility.

The Inboard is available with 0K memory (you can populate the rest yourself at a much lower cost) or 1 Mbyte of factory-installed on-board memory. Also available is a 2-Mbyte daughter board to bring the Inboard up to a total capacity of 3 Mbytes.

The Inboard will work with 0K of memory using the memory on the AT motherboard. Performance suffers, however, dropping to half that achievable with on-board memory. The memory on the Inboard functions as a 32-bit wide memory system with a memory caching circuit. When there is no on-board RAM, the 386 uses the standard 16-bit-wide memory system that does not have caching, and so performance suffers.

Connectivity and Compatibility

Since I connect systems to LANs and mainframes, I am concerned with connectivity—in other words, connecting the system to the outside world via different communication adapter boards. All too often this is a crucial test for PC-compatible systems. I have found that many so-called compatibles cannot support the IBM Token-Ring or IBM 3278 emulation adapters. I was therefore pleased to see that an IBM PC/AT equipped with the Intel Inboard functioned properly with the Token-Ring and 3278 adapters installed.

Software compatibility was another concern. I ran many of the standard PC application programs without any problem. But my prime interest was in the new 386 software. Since this software was designed to run on a Compaq 386, I was interested to see if there would be problems running 386 programs on a converted AT.

I tested Quarterdeck's new release of DESQview (Version 2.0 with the 386 extension), Concurrent DOS 386 from Digital Research (DRI), and PC-MOS/386 from Software Link. All three operate in the true 80386 32-bit mode and provide multitasking/multiuser facilities. After testing each, I began wondering why there should be so much interest in OS/2, which is only a 286-based operating system.

DESQview operated in much the same way as the existing PC version. In fact, regular extended or EMS memory works just as EEMS does. Each task can be maximized for memory utilization. Up to 255 tasks could be initiated under DESQview, provided the resources are there. (Anything more than a dozen would just be an academic exercise.) It worked well. Programs need not be well behaved to function. Best of all, I was not dependent on a mouse in order to run a few tasks. Using Inboard with DESQview was like having a window to the world with computerized speed and multitasking.

DRI's Concurrent DOS 386 operating

Figure 1. Benchmark test results

BENCHMARK	PC/XT	INBOARD 386	COMPAQ 386
1. Mixed Instructions Repetition	10.00	0.98	1.15
Effective 8088 clock speed	4.77 MHz	48.67 MHz	41.47 MHz
2. Eratosthenes Sieve 10 reps	3.68	0.44	0.38

CPU2: Speed checker benchmark program (time in seconds)

	INBOARD 386	COMPAQ 386
Performance relative to PC/XT	12.3x (19.9 MHz)	12.5x (20.2 MHz)

Landmark CPU speed test: Speed version .99

system was also a delight to operate. Although designed for the Compaq 386, the Inboard had no problem running it. Most PC-DOS programs ran concurrently with no problems since Concurrent DOS 386 provides DOS Version 2.x compatibility (Version 3.x compatibility is reportedly being developed). Only programs that went into selective operating system calls were vulnerable to failure. The copy I tested was a beta-test copy, yet the product appeared to be in a finished form since all the features were there and I encountered no bugs.

I also tested a beta copy of Software Link's PC-MOS/386 operating system. This product was designed for the Compaq DeskPro-386, as well, but there was no problem installing and running it on the Inboard. PC-MOS/386 appears, however, to need further development, which will no doubt happen with its formal release and subsequent updates.

I am not a speed enthusiast and I am not particularly concerned with multitasking, but there are times when I wish I could have a little more processing speed and the ability to run another task in the background without seriously affecting performance. The combination of the Intel Inboard 386 with an AT-compatible system seems like a very logical approach.

Summing Up

The Intel 80386 provides the increase in performance that has been sorely needed for true multitasking on the PC. The Compaq 386 was the first system to deliver this level of performance, but at a price. The Intel Inboard 386 provides an alternative upgrading to a Compaq 386 for those who already own an IBM PC/AT or compatible system. §

Hank Kee is in charge of computer support at a large banking institution. He is also co-librarian of the PC/Blue public domain software library, and operates the New York Amateur Computer Club electronic bulletin board system ([718] 539-3338 or [718] 539-3560).

Product Information

Connecting Cables

PCIB3001—for IBM PC/AT	$200
PCIB3002—for AT-compatibles	$200

Intel Inboard 386 AT
(less connecting cable)

PCIB3000—0K memory	$1795
PCIB3010—1-Mbyte RAM	$2295

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80387 Math Coprocessor

PCNC8387-16	$795

Piggyback Memory Boards

PCIB3110—1 Mbyte on board (2 Mbyte in system)	$645
PCIB3120—2 Mbyte on board (3 Mbyte in system)	$1145

Figure 2. MIPS (from Chips and Technologies, Version 1.20)

BENCHMARK	PERFORMANCE RELATIVE TO: IBM/PC 4.77 MHz	IBM/AT 8 MHz	ACTUAL MIPS COMPAQ 386	INBOARD 386
General instructions	5.64	1.64	0.83	0.93
Integer instructions	11.11	1.74	0.76	1.87
Memory to memory	2.93	0.90	0.50	0.69
Register to register	18.31	2.38	1.00	3.29
Register to memory	3.54	1.06	0.59	1.09
Overall performance	*6.32*	*1.53*	*0.75*	*1.57*

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The Software Link's PC-MOS/386

by Charles H. Strom

A Low-cost 80386 Multitasking, Multiuser Operating System

Every day we hear of more 80386 microcomputer systems being introduced. It seems a given in the industry that software always lags far behind hardware. An excellent example is IBM's PC/AT, an 80286-based system introduced in 1984, and the operating system for it, OS/2, which will not be available until 1988—a four-year lag. With the 80386 systems, however, such is not the case.

Within nine months of the introduction of the first 80386 system (the Compaq DeskPro 386), several 80386 operating systems have been announced. I would like to introduce and give an overview to one of these systems, PC-MOS/386, from The Software Link. The Software Link is best known for MultiLink and LanLink, two networking products that run in conjunction with PC/MS-DOS. PC-MOS/386 (referred to as "MOS" in the balance of this article) is the company's first foray into the operating system market.

Overview

A primary design goal of this operating system was to maximize compatibility with as many PC/MS-DOS 3.2 applications as possible. The virtual 8086 mode of the 80386 allows this while taking advantage of the protected environment. Along with virtual mode, paging allows each multiple application to see the same 640K PC/MS-DOS address space. Lastly, MOS is said to support 32-bit native mode, although no examples of such code were on hand to test. MOS takes advantage of the design of the microprocessor and its ability to directly address large blocks of RAM to support both multitasking and multiuser operation.

Multitasking

Three versions of the operating system support one, five, and twenty-five users. Actually, "MOS" stands for modular operating system; it is easy to upgrade to the multiuser versions by simply adding a module. In all cases, multitasking is available (within the limits of available RAM) by defining memory partitions as needed. For example, an "ADDTASK 384" will create an additional partition of 384K. Keying Alt-1 will switch to partition 1, Alt-2 to partition 2, and so on. The maximum partition size is approximately 640K. Utilities are also included to remove or resize partitions. When more than one process is running—whether due to a single user running several tasks, several users each running a task, or some combination—there are two types of priority assignments: (1) the SLICE subcommand controls the number of time slices (of approximately 1/18 second duration) devoted to each task and (2) the PRIORITY subcommand allows eight levels of priority. A task with lower priority will not execute until all higher priority tasks are complete. The power and flexibility of these commands illustrate the careful planning that went into MOS.

Multiuser

Many of the details discussed above can also be applied to multiuser configurations of MOS. A variety of terminals is supported, including Zenith's Z-19; the Televideo 910, 912, 920C and 925; the ADM-3A, ANSI terminals; and so on. Also, any of the PC-compatible terminals (such as the Kimtron KT-7 and Wyse WY-60) can be used. Even dumb, teletypelike terminals can be used. Since there is provision for a user-defined terminal driver, almost any hardware will work.

Note that MOS treats remote terminals as monochrome displays. At present, graphics are not supported because The Software Link has yet to develop the necessary driver, but a CGA version is expected soon. The company does market a product called PC-Emulink, which allows a CGA-equipped computer to serve as a

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Requires 48K memory. Version 1.2.

Meridian Software
AdaVantage Compiler 2.0
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The Meridian AdaVantage Compiler is a fully validated implementation of the Ada language. The compiler generates native 8086 code in the Intel standard object format. A linker is provided to create stand-alone executable files for MS-DOS. The Meridian AdaVantage Compiler package includes the compiler, linker, library management tools, support packages, runtime libraries and a configuration tool. In addition to the standard Ada packages, support packages are provided to make integer, floating point and text I/O more convenient to implement. The compiler also provides a pragma INTERFACE used to make calls to subprograms written in 8086 assembly language, Meridian C or Meridian Pascal. A source level debugger will be available in late 1987.

Requires hard disk and 640K memory. Runtime fees apply if more than 99 copies are sold. Version 2.0.

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1st-CLASS *by Programs in Motion*	495	399
EXSYS *Development Software by EXSYS*	395	309
EXSYS Runtime System	600	469
LEVEL5 *by Information Builders* ... *New*	685	569
Logic-Line Series *All varieties by Thunderstone*	CALL	CALL

ai - lisp language

Golden Common LISP *by Gold Hill*	495	CALL
Golden Common LISP Developer *by Gold Hill*	1190	CALL
Q'Nial *Various by NIAL Systems*	CALL	CALL
Star Sapphire LISP *Compiler by Sapiens* ... *New*	495	429
TransLISP PLUS *from Solution Systems*	195	125

ai - prolog language

Arity Combination Package	1095	979
Expert System Development Pkg	295	229
File Interchange Toolkit	50	44
PROLOG Compiler & Interpreter	650	569
Screen Design Toolkit	50	44
SQL Development Package	295	229
Arity PROLOG Interpreter	295	229
Arity Standard Prolog	95	77
LPA microPROLOG *All Varieties*	CALL	CALL
MPROLOG Language Primer *LOGICWARE*	50	45
MPROLOG P500 *by LOGICWARE*	495	395
MPROLOG P550 *w/Primer by LOGICWARE*	220	175
Turbo PROLOG *by Borland Intl*	100	64
Turbo PROLOG Toolbox *by Borland Intl*	100	64

ai - smalltalk language

Smalltalk/V	100	84
EGA/VGA Color Option	50	45
Goodies Diskette	50	45
Smalltalk/Comm	50	45

ai - texas instruments

Arborist *Decision Tree Software*	595	519
PC Scheme *Lisp* ... *New Version*	95	84
Personal Consultant Easy ... *New Version*	495	435
Personal Consultant Image	495	435
Personal Consultant Online	995	869
Personal Consultant Plus ... *New Version*	2950	2589
Personal Consultant Runtime	95	84

ada language

AdaVantage *GSA-Validated by Meridian Software*	795	735
AdaVantage Utility Packages	50	47
DOS Environment Package	50	47
Janus/ADA C Pak *by R&R Software*	95	84
Janus/ADA D Pak *by R&R Software*	1250	1059
Janus/ADA ED Pak *by R&R Software*	395	349

apl language

APL*PLUS PC *by STSC*	695	495
APL*PLUS PC Spreadsheet Mgr *by STSC*	195	139
APL*PLUS PC Tools Vol 1 *by STSC*	295	199
APL*PLUS PC Tools Vol 2 *by STSC*	85	58
APL*PLUS PS/2 *by STSC* ... *New*	695	495
ATLAS*GRAPHICS *by STSC*	450	329
Financial/Statistical Library *by STSC*	275	189
Pocket APL *by STSC*	95	69
STATGRAPHICS *by STSC*	895	649

assembly language

386 ASM/LINK *Cross Asm by Phar Lap*	495	389
8088 Assembler *w/Z-80 Translator by 2500 AD*	100	89
ASMLIB *Function Library by BCSoft*	149	125
asmTREE *B-Tree Dev System by BCSoft*	395	329
Cross Assemblers *Various by 2500 AD*	CALL	CALL
EZASM *by C Source*	70	59
Microsoft Macro Assembler	150	93
Turbo Debugger *by Speedware*	89	79
Turbo Editasm *by Speedware*	99	84
Visible Computer: 8088 *by Software Masters*	80	64

basic language

db/Lib *for QuickBASIC by AJS Publishing*	139	119
Finally *by Komputerwerk*	99	85
MACH 2 *by Micro Help*	69	55
Microsoft QuickBASIC	99	63
QBase *Relational Database by Crescent*	89	79
Quick-Tools *by BCSoft*	130	109
QuickPak *by Crescent Software*	69	59
Scientific Subroutine Library *by Peerless*	125	99
Screen Sculptor *by Software Bottling*	125	91
Stay-Res *by MicroHelp*	69	55
True Basic *w/Run-time* ... *Special Price*	200	99
True Basic	100	79
Run-time Module	100	79
Various Utilities	50	41
Turbo BASIC Compiler *by Borland Intl*	100	64

blaise products

ASYNCH MANAGER *Specify C or Pascal*	175	135
C TOOLS PLUS/5.0 ... *New Version*	129	99
KeyPlayer *Super Batch Program* ... *New*	50	45
LIGHT TOOLS *for Datalight C*	100	65
PASCAL TOOLS	125	95
PASCAL TOOLS 2	100	79
PASCAL TOOLS & TOOLS 2	175	135
RUNOFF *Text Formatter*	50	45
TURBO ASYNCH PLUS	100	79
TURBO C TOOLS	129	99
TURBO POWER TOOLS PLUS	100	79
VIEW MANAGER *Specify C or Pascal*	275	199

borland products

EUREKA *Equation Solver*	167	105
Reflex: The Analyst	150	99
Sidekick	85	57
Superkey	100	64
Turbo Basic Compiler	100	64
Turbo Basic Database Toolbox	100	64
Turbo Basic Editor Toolbox	100	64
Turbo Basic Telecom Toolbox	100	64
Turbo C Compiler *(Call for support products)*	100	64
Turbo Lightning and Word Wizard	150	94
Turbo Lightning	100	64
Turbo Lightning Word Wizard	70	47
Turbo Pascal and Tutor ... *New Version*	CALL	CALL
Turbo Pascal ... *New Version*	100	64
Turbo Pascal Tutor ... *New Version*	70	41
Turbo Pascal Database Toolbox ... *New Version*	100	64
Turbo Pascal Editor Toolbox ... *New Version*	100	64
Turbo Pascal Gameworks Toolbox ... *New Version*	100	64
Turbo Pascal Graphix Toolbox ... *New Version*	100	64
Turbo Pascal Numerical Methods Toolbox ... *New*	100	64
Turbo Prolog Compiler	100	64
Turbo Prolog Toolbox	100	64

c compilers

C86PLUS *by Computer Innovations*	497	359
DeSmet C *w/Debugger & Large case*	209	184
DeSmet C *w/Debugger only*	159	138
Eco-C *Complete System by Ecosoft*	140	119
Instant C *by Rational Systems*	495	369
Instant-C/16M *by Rational Systems* ... *New*	895	695
Lattice C Compiler *vers. 3.2 from Lattice*	500	265
Mark Williams Let's C w/csd	75	54
Microsoft C Compiler w/CodeView ... *New Version*	450	269
Microsoft QuickC Compiler ... *New*	99	63
Optimum-C *by Datalight*	139	95
Turbo C Compiler *by Borland*	100	64
Uniware 68000/10/20 Cross Compiler *by SDS*	995	829

c interpreters

C-terp *by Gimpel, Specify compiler*	298	219
C Trainer *with Book by Catalytix*	122	87
Introducing C *by Computer Innovations*	125	99
Run/C *by Age of Reason*	120	69
Run/C Professional *by Age of Reason*	250	145

c utilities

Blackstar C Library *by Sterling Castle* ... *New*	125	98
C++ *by Guidelines w/version 1.1 kernel*	195	172
c-tree & r-tree Combo *by FairCom*	650	519
c-tree *ISAM File Manager*	395	315
r-tree *Report Generator*	295	239
Csharp Realtime Toolkit *by Systems Guild*	600	489
Curses Window Dev Pkg *by Aspen Scientific* .. *New*	119	105
with Source Code	289	249
dBx *dBASE to C Translator by Desktop AI*	350	299
with Source Code	550	419
Flash-up Windows *by Software Bottling*	90	78
GraphiC *Color version by Sci Endeavors*	350	274
GRAFLIB *by Sutrasoft*	175	159
HALO *Graphics by Media Cybernetics*	300	205
HALO Development Pkg *for Microsoft*	595	389
The HAMMER *by OES Systems*	195	129
PANEL *Forms Management by Roundhill*	295	215
PANEL/TC *for Turbo C by Roundhill*	129	95
PANEL Plus *by Roundhill*	495	395
PC Lint *by Gimpel Software*	139	99
PLOTHP *by Sutrasoft*	175	159
RTC PLUS *Fortran to C by Cobalt Blue*	450	399
Sapiens V8 *Virtual Memory Manager* ... *New*	300	265
Scientific Subroutine Library *by Peerless*	175	135
TE Text Editor *source by Sub Systems*	95	85
Vitamin C *by Creative Programming*	225	149
VC Screen *Forms Designer*	100	79
Zview *by Data Mgmt Consultants*	245	139

cobol language

COBOLspll *by Flexus*	395	329
FPLIB *for Realia COBOL by BCSoft*	149	129
Micro Focus COBOL *See Micro Focus Section*		
Microsoft COBOL *See Microsoft Section*		
PCDT *by Pro-Code*	995	895
Realia COBOL with RealMENU	1145	899
Realia COBOL	995	783
RealCICS	995	783
RM/COBOL *by Ryan-McFarland*	950	639
RM/COBOL 85 *by Ryan-McFarland*	1250	895
RM/NET+5 *by Ryan-McFarland* ... *New*	300	259
RM/Screens ... *New*	395	334
SCREENIO *by Norcom*	400	379
screenplay *for COBOL by Flexus*	175	129

css products

Combo Package *by Custom Software Systems*	199	175
PC/SPELL *Spelling Checker*	49	45
PC/TOOLS *UNIX-like Utilities*	49	45
PC/VI *vi Editor*	149	99

debuggers & profilers

386 DEBUG *Cross Debugger by Phar Lap*	195	129
Advanced Trace-86 *by Morgan Computing*	175	115
Codesmith-86 *by Visual Age*	145	98
DSD87 *by Soft Advances*	125	79
MiniProbe *by Atron*	395	369
Periscope I *with Board by Periscope*	345	275
Periscope II *with NMI Breakout Switch*	175	139
Periscope II-X *Software only*	145	105
Periscope III *8 MHz version*	995	795
Periscope III *10 MHz version*	1095	875
The PROFILER *with Source Code by DWB*	125	89
TURBOsmith *Source debugger for Turbo Pascal*	99	89
The WATCHER *Profiler by Stony Brook*	60	51

disk utilities

Back-It *by Gazelle Systems* ... *New Version*	130	115
Disk Optimizer *by Softlogic Systems*	60	55
Disk Technician *by Prime Solutions* ... *New*	100	89
FASTBACK *by 5th Generation Systems*	179	129
Vcache *by Golden Bow Systems*	50	47
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Vfeature Deluxe *by Golden Bow Systems*	120	111
XenoCopy-PC *by XenoSoft*	80	69

dos utilities

Advanced Norton Utilities	150	99
Command Plus *by ESP Software*	80	69
Desqview *from Quarterdeck*	100	85
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Mace Utilities *Paul Mace Software* ... *New*	99	89
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essential products

C Utility Library	185	119
Essential Comm Library *with Debugger*	250	189
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forth language

CFORTH *Native Code Compiler by LMI*	300	229
FORTH/83 Metacompiler *Specify Target*	750	599
PC/FORTH *by Laboratory Microsystems*	150	109
PC/FORTH+ *by Laboratory Microsystems*	250	199
Programmer's Package #1 *by LMI* ... *New*	250	199
Programmer's Package #2 *by LMI* ... *New*	350	279
Programmer's Package #3 *by LMI* ... *New*	500	399
UR/FORTH *Also Available for OS/2 by LMI*	350	279
UR/FORTH Libraries	500	395

fortran language

50 MORE: FORTRAN *by Peerless Scientific*	125	95
ACS Time Series *by Alpha Computer Service*	495	389
AUTOMATED PROGRAMMER *by KGK Automated*	995	949
Essential Graphics *by Essential Software*	250	183
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FORTLIB *by Sutrasoft*	125	109
FORTRAN Addendum *by Impulse Engr*	95	85
FORTRAN Addenda *by Impulse Engr*	165	138
GRAFLIB *by Sutrasoft*	175	159
HALO *Graphics by Media Cybernetics*	300	205
I/O PRO w/No Limit Library *by MEF*	250	219
Microcompatibles Combo Package	240	215
Grafmatic	135	117
Plotmatic	135	117
Microsoft FORTRAN *w/CodeView*	450	269
No Limit Library *by MEF Environmental*	129	109
Numerical Analyst *by MAGUS*	295	249
PANEL *by Roundhill Computer Systems*	295	215
PLOTHP *by Sutrasoft*	175	159
RM/FORTRAN *by Ryan-McFarland* ... *New Version*	599	399
RTC PLUS *Fortran to C by Cobalt Blue*	450	399
Scientific Subroutine Lib *by Peerless*	175	135
Statistician *by Alpha Computer Service*	295	235
STATLIB.GL: *by Peerless*	295	239
STATLIB.TSF: *by Peerless*	295	239
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greenleaf products

Greenleaf C Sampler *for Turbo C & QuickC* ... *New*	95	69
Greenleaf Comm Library	185	125
Greenleaf Data Windows Library	225	155
with Source Code	395	249
Greenleaf Functions	185	125

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lattice products

Lattice C Compiler *ver 3.2 from Lattice*	500	265
with Library Source Code	900	495
C Cross Reference Generator	50	37
with Source Code	200	139
C-Food Smorgasbord *Function Library*	150	95
with Source Code	300	179
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with Source Code	250	169
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with Source Code	500	356
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SEU *Source Entry Utility*	250	199
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Micro Focus Level II COBOL *w/Animator*	495	395
Level II COBOL	349	279
Level II Animator	195	155
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COBOL/IQ *Ad hoc Report Writer*	495	395
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FORMS-2	295	235
SOURCEWRITER	995	795

microport products

386 Unlimited License Kit	249	209
AT Unlimited License Kit	249	209
DOSMerge286 *Run DOS and UNIX together*	149	129
DOSMerge386 *Run DOS and UNIX together*	CALL	CALL
System V/386 Combination	799	699
386 Runtime System	199	169
386 Software Development System	499	429
Text Preparation System	199	169
System V/AT Combination	549	465
AT Runtime System	199	169
AT Software Development System	249	209
Text Preparation System	199	169

microsoft products

Microsoft BASIC Compiler *for XENIX*	695	419
Microsoft BASIC Interpreter *for XENIX*	350	209
Microsoft C Compiler *w/CodeView .... New Version*	450	269
Microsoft COBOL Compiler *with COBOL Tools*	700	429
for XENIX	995	609
Microsoft FORTRAN *Optimizing Compiler/CodeView*	450	269
Microsoft FORTRAN *for XENIX*	695	419
Microsoft Learning DOS	50	36
Microsoft MACH 10 *with Mouse & Windows*	549	369
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Microsoft Mouse *Serial Version*	CALL	CALL
Microsoft Pascal Compiler	300	179
for XENIX	695	419
Microsoft QuickBASIC	99	63
Microsoft QuickC ..... *New*	99	63
Microsoft Windows	99	63
Microsoft Windows Development Kit	500	299
Microsoft Word ..... *New Version*	450	269

mks products

MKS AWK ..... *New*	75	65
MKS RCS *Revision Control System* ..... *New*	189	155
MKS Toolkit *with MKS VI Editor*	139	109
MKS Trilogy *with AWK, CRYPT & Korn Shell ... New*	119	99
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modula-2 language

LOGITECH Modula-2 Development System .... *New*	249	199
Modula-2 Compiler Pack ..... *New*	99	79
Modula-2 Toolkit ..... *New*	169	139
LOGITECH Modula-2 ROM Pkg	299	239
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ModGraph *by TEQNA* ..... *New*	50	45
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Science & Engrg Tools *by Quinn-Curtis*	75	67
Universal Graphics Library *by Quinn-Curtis*	130	119

mouse products

LOGIMOUSE BUS *with PLUS Pkg by LOGITECH*	119	98
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Microsoft Mouse *See Microsoft Section*		

other languages

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SuperSort *by LifeStyle* ..... *New*	139	119

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Pre-C *Lint Utility*	295	154
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polytron products

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PolyDesk III Archivist	50	42
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PolyXREF *One language only*	129	109
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raima products

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Multi-User with Source Code	990	699

sco products

Complete XENIX System V *by SCO*	1295	994
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XENIX System V 386 *by SCO* ..... *New*	CALL	CALL

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SPF/PC *by Command Technology Corp*	CALL	CALL
Vedit Plus *by CompuView*	185	128

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ALICE *Interpreter by Software Channels*	95	66
DOS/BIOS & Mouse Tools *by Quinn-Curtis*	75	67
Flash-up Windows *by Software Bottling*	90	78
MACH 2 *for Turbo Pascal by Micro Help*	69	55
MetraByte D/A Tools *by Quinn-Curtis*	100	89
Science & Engrg Tools *by Quinn-Curtis*	75	67
Screen Sculptor *by Software Bottling*	125	91
Speed Screen *by Software Bottling*	35	32
System Builder *by Royal American* .... *New Version*	150	129
IMPEX *Query Utility*	100	89
Report Builder ..... *New Version*	130	115
TDebugPLUS *by TurboPower Software*	60	49
Tmark *by Tangent Designs*	80	69
Turbo EXTENDER *by TurboPower Software*	85	64
Turbo OPTIMIZER *by TurboPower*	75	65
with Source Code	125	98
Turbo Professional *by Sunny Hill*	70	45
TurboHALO *from IMSI*	129	98
TurboPower Utilities *by TurboPower*	95	78
TurboRef *by Gracon Services*	50	35
TURBOsmith *Source Debugger by Visual Age*	99	89
Universal Graphics Library *by Quinn-Curtis*	130	119

wendin products

Operating System Toolbox	99	79
PCNX *Operating system*	99	79
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Wendin-DOS *Multitasking DOS*	99	85
Wendin-DOS Application Developer's Kit ..... *New*	99	85
XTC *Text Editor w/Pascal source*	99	75

xenix/unix products

Btrieve *ISAM File Mgr by SoftCraft*	595	454
C-terp *by Gimpel, Specify compiler*	498	379
c-tree *ISAM Mgr by FairCom*	395	315
dBx *with Library Source by Desktop AI*	550	419
DIRECTORY SHELL 286		
by American Mgmt Sys ..... *New*	349	295
DIRECTORY SHELL 386		
by American Mgmt Sys ..... *New*	495	415
DOSIX *Console Version by Data Basics*	400	349
DOSIX *User Version by Data Basics*	200	179
Micro Focus Products *See Micro Focus Section*		
Microport Products *See Microport Section*		
Microsoft Products *See Microsoft Section*		
PANEL Plus *by Roundhill Computer Systems*	795	535
REAL-TOOLS *Binary Version by PCT*	99	89
Library Source Version	599	539
Complete Source Version	999	729
RM/COBOL *by Ryan-McFarland*	1250	949
RM/FORTRAN *by Ryan-McFarland*	750	549
SCO Products *See SCO Section*		

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fully supported remote graphics device. The necessary driver to support dumb, CGA-compatible terminals is expected in a future release. Functions that are available at present include dual intensity, cursor movement and addressing, and full support for function keys, the Alt key, and the special keypad keys (home, end, page up, and so on), among others.

To set up the operating system for multiuser operation, the $SERIAL.SYS device driver is used. This specifies the port addresses, buffer size, handshaking, and other parameters. The manual also describes the simple steps required to set up a modem as a remote terminal, thus supporting remote access to the system.

Device drivers

One of MOS' strengths is its support of device drivers. Unlike the situation with PC/MS-DOS, device drivers can be dynamically added to and removed from MOS at any time through the use of *.ADDEV* and *.REMDEV* commands. This simple process eliminates the need for shutting down the system and rebooting to change the environment, as is often necessary when running PC/MS-DOS. The Software Link supplies several special drivers including cache, extended memory emulator, RAM disk, and NETBIOS drivers. This last driver allows each of multiple partitions to emulate a stand-alone machine on a LAN, thus allowing the system to run LAN software or intertask communication with file and record locking. Of course, the dynamic allocation and deallocation of device drivers will operate nicely with any driver, not just those that The Software Link provides. This capability is a big plus.

General Commands

MOS is designed from the ground up as a complete replacement for PC/MS-DOS. It capitalizes on the user's knowledge of the latter by employing familiar command names and syntax. There are two basic command groups, *intrinsic* and *extrinsic*. The former are resident in $$SHELL.SYS and are always available in memory. Examples are *DIR, ERASE, MD, CD*, and so on, while the latter include *FORMAT, DISKID, FILEMODE*, and so on. The *HDSETUP* command replaces *FDISK* and allows an active partition larger than PC/MS-DOS' 32-Mbyte limit. The downside, of course, is that PC/MS-DOS will no longer operate correctly on such a partition.

Rather than listing every MOS command and its corresponding PC/MS-DOS command, let it suffice to say that MOS offers all that PC/MS-DOS has and then some. There are both an editor (sporting line- and screen-oriented modes) and a debugger. *DEBUG* has some enhancements over PC/MS-DOS' debugger. For example, a *SWAP* command allows the screen to alternately display the actual program and the debugger. In addition, you can use a terminal for *DEBUG* while running the application on the main console.

The BATCH Command

Once again, MOS builds on PC/MS-DOS by enhancing the batch processor. BATCH allows nesting of batch files. There is a command that permits changing directories within a batch file and returning to the original directory. There are also CALL/RETURN, FOR IN DO, GOTO, and IF constructs. This is not an exhaustive list, but it serves to illustrate the power of the batch processor.

Compatibility

The Software Link explains that MOS is designed to run most applications that were written to execute under PC/MS-DOS in the 8086 mode. The operating system is said to fully support the monochrome mode at all terminals, and CGA on both the main console and at remote CGA terminals (as previously mentioned, the latter is possible in theory but presently is supported only through the use of remote computers and an add-on package). EGA is supported on the main console only.

Unfortunately, The Software Link says very little about the issue of compatibility with PC/MS-DOS applications. In order to get a feel for compatibility, a shotgun approach was used, running numerous applications. In every case, text-mode applications (WordStar, Supercalc 4, dBASE III, Microsoft Word in character mode, and so on) operated flawlessly. It was a simple matter to run several of these applications simultaneously in several partitions.

Several communications programs were also tried, since the power to perform xmodem file transfers in the background while doing other tasks in the foreground is extremely useful. Procomm, Qmodem, and Pro-YAM offered no problems.

Graphics applications were a different story, however. The hardware configuration for testing includes a Tseng EVA/480 display board, which may be among the

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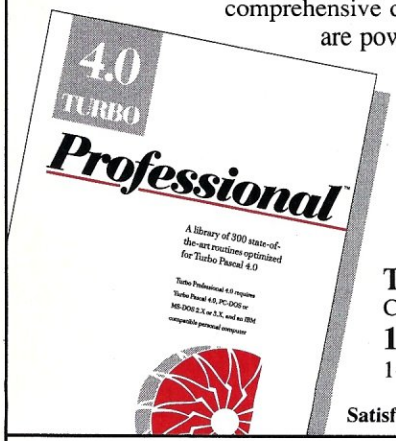

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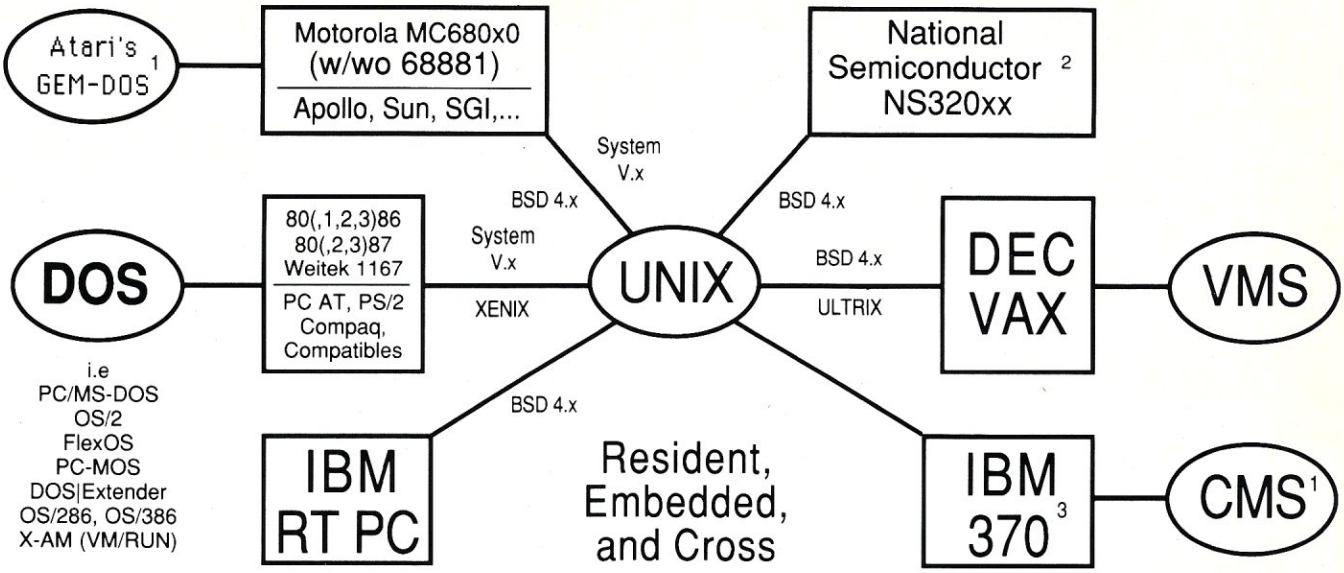

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Footnotes: 1. Atari, CMS versions available 10/87. 2. NS320xx version by special order. 3. UNIX not yet available on 370.

best of the breed of hybrid video boards, supporting monochrome text, EGA, and CGA applications virtually seamlessly under PC/MS-DOS. MOS was another story. For example, Ventura Desktop Publisher could be loaded and executed except that the lower half of the EGA screen was obliterated by a solid pattern. Autocad's menus were fine, but when the system was instructed to draw a screen, it did not display. Similarly, Microsoft Word, in its default graphics mode, crashed the system. During consultation with the MOS technical support people, they verified that correct operation of EGA applications is currently a problem, but added it is a high priority for the next release.

The package comes with a notice that all users of the first release (1.01) will be upgraded to the next version some time in the next several months, free of charge. Hopefully, this is, indeed, one of the areas that will receive attention in the next release. A pure EGA-only card might have been more successful, and a CGA-equipped machine would have certainly operated correctly with graphics applications.

In summary, MOS does not get a strong positive vote as far as compatibility with graphics applications that do work satisfactorily under PC/MS-DOS, but The Software Link will probably address this area in the next version.

Performance

I ran several benchmarks (Norton, MIPS, and Version 4 of the *PC Magazine* benchmarks) under MOS and compared them to results under PC/MS-DOS. In every case, results were identical. Of course, these tests were conducted with only one MOS partition active. The tests show that there is no unusual overhead encountered under MOS.

Summary

PC-MOS/386 is an ambitious effort on the part of a small firm to leapfrog over Microsoft and offer a protected environment operating system on the 80386. And the effort has succeeded while maximizing compatibility with existing applications. Some kinks remain in the handling of graphics applications and there are a few minor bugs in some of the commands, but in general, MOS is a successful alternative to waiting for OS/2. Multitasking and multiuser operation on a 386 is a reality.

MOS' pricing is also attractive, with the single-user version at $195, the five-user version $595, and the twenty-five-user version $995. And discounted products are already appearing in the marketplace. MOS certainly bears serious investigation by all PC/MS-DOS users with 80386 systems. §

Charles Strom is Director of Laboratories and Director of Technical Services manager of the Department of Chemistry for New York University and is actively involved with microcomputer facilities development at the university. He is also the PC sysop on the GEnie national time-sharing service.

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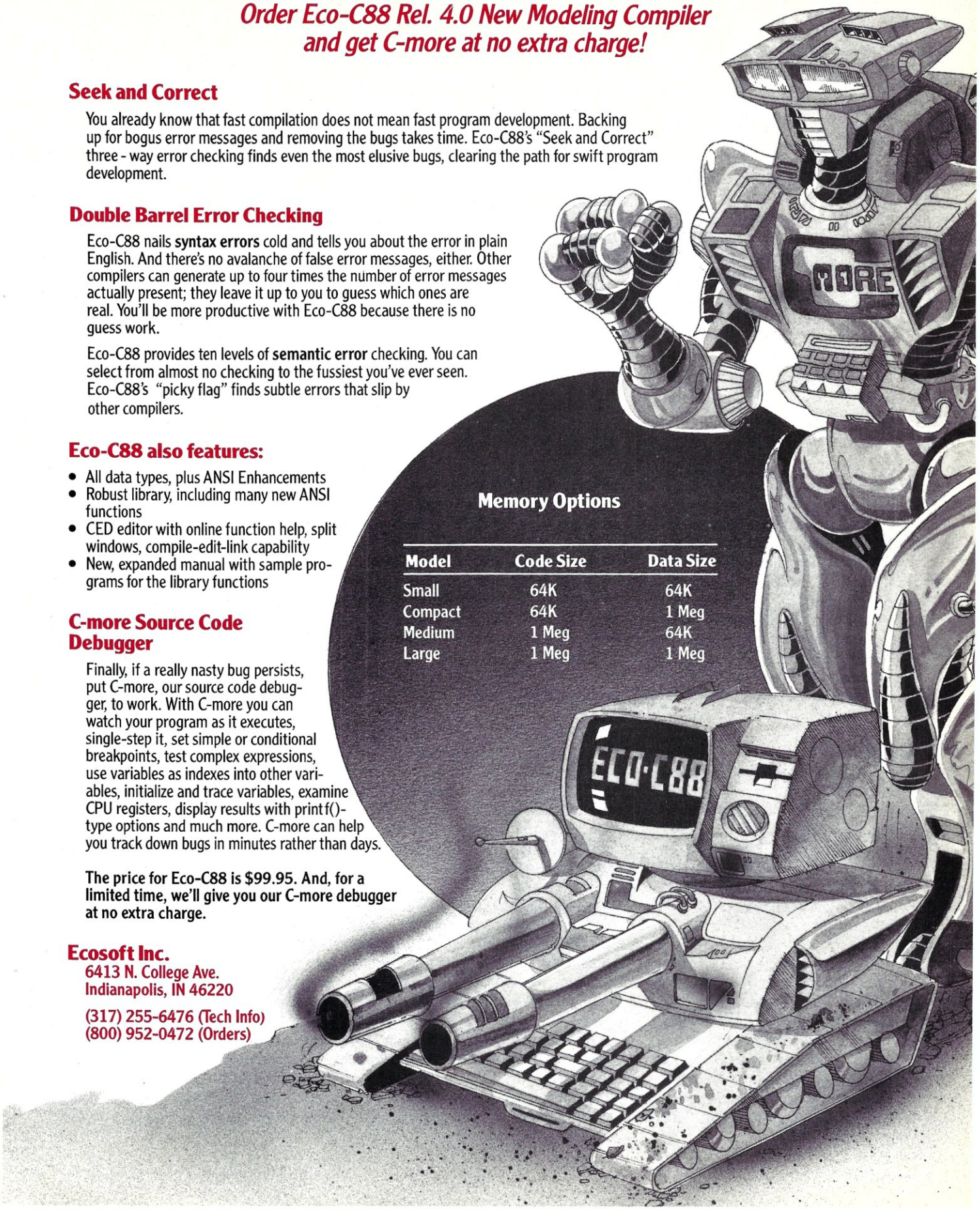

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Intel's iSBC 386AT

by Jeff Duntemann

A lot of people (myself included) were surprised at the speed with which the mail-order clone companies began offering 32-bit 80386 systems. Behind the surprise was the fact that Intel had quietly begun shipping OEM quantities of its iSBC 386AT motherboard. The iSBC 386AT, installed in an AT-clone cabinet, allows a highly IBM compatible 386 machine to be assembled with virtually no engineering. Many mail-order 386 compatibles incorporate the board, which is also available via some Intel distributors.

Overview

The iSBC 386AT has the same physical dimensions as the IBM PC/AT motherboard. It can thus be installed in any case designed for IBM PC/AT or compatible motherboards. The iSBC 386AT has 512K × 8 of socketed RAM that runs with effectively one wait state at both the 16-MHz and 6-MHz processor clock rates. It contains eight expansion slots: two 8-bit PC-compatible slots, four 16-bit AT-compatible slots, and two 32-bit slots of Intel's own design (and used nowhere else to my knowledge). The 32-bit slots will accept 8-bit cards but are keyed to prevent insertion of 16-bit cards. While the 32-bit slots operate at the full 16-MHz clock rate, the 8- and 16-bit slots operate at 8 MHz. Up to 16 Mbytes of RAM may be installed on the bus. The AT-compatible ROM BIOS is from Phoenix Technologies.

An AT-compatible keyboard may be plugged into the DIN-style keyboard connector. A CMOS battery-operated real-time clock chip also contains 50 bytes of nonvolatile RAM to hold setup information during power-down periods. Unlike the IBM PC/AT, there are RS232C serial and Centronics-compatible parallel ports on the board.

Memory Architecture

Over the past year or two, the speed of processors has begun outrunning memory systems. The absurdity of cranking up a 4.77-MHz PC to 9.54 MHz and then throttling the effective clock speed back to 6 MHz by adding wait states is only now being recognized. The key to machine performance is not CPU speed but memory architecture and access time.

IBM's PC/XT-286 appears to operate much more quickly than its 6-MHz 80286 processor would suggest because it is running its memory system without wait states. Both the 6-MHz and 8-MHz PC/AT's run with one wait state, and most *turbo* boards without on-board memory that are sold for the 8-bit PC/XT bus add two or more wait states to allow the fast CPU to work with the much slower XT bus and memory.

A wait state is simply an extra bus access cycle requested of the CPU by external hardware. This extra cycle merely provides a pause while the memory system (or some other system running more slowly than the CPU) does what it must and catches up to the CPU.

The relationship between clock speed and wait states is not a simple one. In order to operate at 16 MHz with zero or one wait state, the 80386 would require very fast DRAM in the 50–60 ns range. DRAM chips with access times of less than 100 ns are still premium parts and very expensive by microcomputer standards.

To keep the price of the memory system down, more cleverness is required of the memory system. The iSBC 386AT's memory system takes advantage of the reason why wait states are necessary to begin with: DRAM refresh. Once you read data from a DRAM, you must allow a period of time to pass before reading it again to *refresh* it at least once between reads.

The iSBC 386AT memory system is split into two banks, and successive 32-bit (4-byte) blocks of memory alternate between the two banks. In other words, Bank A contains memory locations 0–3, Bank B contains memory locations 4–7, Bank A contains memory locations 8–11, Bank B contains memory locations 12–15, and so on, with every other 32-bit block of memory belonging to every other memory bank. Since the 80386 fetches memory from the bus 32 bits at a time, successive

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memory accesses will alternate banks. This allows the 386 to read 32 bits from Bank A, and then immediately read another 32 bits from Bank B, because while Bank B is being accessed, Bank A can be refreshed. When it is time for the third access to be made, Bank A has been refreshed and is ready to be accessed.

This alternate-bank system allows the use of 120 ns DRAM at 16 MHz with only one wait state. The DRAM chips are 64K × 4, with each bank arranged as 256K × 8. This setup is the reason why there is only 512K and not 640K DRAM on the board. The alternate-bank system requires two identical banks of DRAM, but there is no convenient way to create two 320K banks of DRAM without covering the motherboard with 64K chip sockets. This is a serious problem, as I will describe in more detail below.

The 80386 CPU contains another trick called *address pipelining*, which essentially puts the next address out on the bus while data at the current address is still being fetched. Address pipelining allows the slower memory system to get a head start on the next memory read if the next read is in the alternate or *nonbusy* memory bank.

The downside of this memory system trickery is that it is not possible to flatly state that the memory system runs with one or two or any number of wait states. Normal code tends not to be consistent in accessing memory neatly in alternate 32-bit chunks, and successive accesses to the same bank trigger a three-wait-state penalty. For example, the 80386's prefetch queue, when active, always reads 32-bit blocks from alternating memory banks. If a register-intensive code sequence is running and the 80386's prefetch queue is constantly in use, the system will run with one wait state. However, as soon as the prefetch queue must be purged (for example, if a jump instruction is executed) the situation becomes much more complicated. Remarkably, the repeating string instructions set off a veritable explosion of wait states, especially the STOSB and MOVSB instructions that write sequential data 1 byte at a time, because they write four times in succession within a single memory bank. In practice, the number of wait states on the bus depends heavily on the nature of the code being executed, but the chances of incurring a wait-state penalty above the normal one wait state are about 50 percent.

The iSBC 386-AT contains two 32-bit expansion slots of Intel's own design.

Table 1. Performance Tests

Peter Norton's SI Utility rates the iSBC 386AT at 18.7. The best single-value benchmark, however, is Landmark Software's SPEED which takes memory system performance into account, and which rates the iSBC 386AT at 15.6, a rough equivalent to the IBM PC/AT running at 15.6 MHz.

A PERFORMANCE SUMMARY	
Landmark	15.6 MHz AT equivalent
SPEED	8.3 times PC/XT performance
Peter Norton's SI Utility	18.7

PC Labs' benchmarks below substantiate my own findings with regard to memory/memory compilation performance. (I compiled a 740-line Turbo Pascal source file for a "whereis" utility in 7.4 seconds going from memory to memory on a PC, and in 1.8 seconds on the iSBC 386AT.)

TEST	TIME IN SECONDS	SPEED INDEX RELATIVE TO 4.77 MHz PC	SPEED INDEX RELATIVE TO 8.0 MHz AT
1. 128K NOP loop	2.09	4.8	2.0
2. Do-nothing loop	1.87	5.3	2.0
3. Integer add loop	1.10	9.0	1.9
4. Integer multiply loop	0.66	15.2	1.8
5. String sort and sort	1.59	6.7	1.8
6. Prime number sieve	1.98	7.8	2.1
7. 8086/8088 instruction set	4.94	6.5	1.8

Chips & Technologies MIPS seems to indicate that the iSBC 386AT has the same speed as an 8-MHz IBM AT, which simply isn't the case. In general, benchmark tests are poor substitutes for loading real applications. My favorite is Microsoft Windows, which runs faster on the iSBC 386AT than on anything without a 386.

	IBM XT 4.77 MHz	IBM AT 8.0 MHz	COMPAQ 386	INTEL 386 AT
1. General instructions	6.48	1.88	0.95	1.07
2. Integer instructions	14.08	2.19	0.96	2.35
3. Memory to memory	5.48	1.69	0.94	1.30
4. Register to register	17.81	2.31	0.97	3.20
5. Register to memory	5.68	1.71	0.94	1.75
6. Performance rating	8.05	1.94	0.95	1.93

These slots are actually expansions of the PC/XT-style 8-bit bus rather than the PC/AT's 16-bit bus. Eight-bit expansion boards may be plugged into the forward portion of a 32-bit slot, but, as noted earlier, the slot is keyed to prevent insertion of a 16-bit board.

The 32-bit extension is little more than the 80386's 32-bit addressing machinery brought from the CPU chip to the bus. The 32-bit slots are obviously intended for memory boards rather than other peripherals, which stand to gain little from being redesigned as 32-bit devices. Intel sells a 2-Mbyte, one-wait-state memory board for these slots, and very recently Fortron Corporation has begun offering a similar 2-Mbyte board for the Intel 32-bit bus. This latter allows up to 4 Mbytes of 32-bit RAM, using currently available expansion boards. Intel has announced but has not yet shipped an 8-Mbyte, 32-bit RAM board for the 32-bit bus. These boards offer the same alternate-bank structure and address pipelining features used on the motherboard, and are otherwise similar except that they are extended memory rather than real-mode memory and cannot be mapped into the lower 640K.

This leads us to the single largest defect of the iSBC 386AT design: There is no way to install true 32-bit RAM between the 512K and 640K boundaries. The motherboard sockets cannot be reconfigured for other types of chips, and the 32-bit boards can be used only as extended RAM past 1 Mbyte. The only way to make the board into a 640K system is to fill the missing 128K with a 16-bit expansion board in one of the 16-bit slots. A number of 128K short-slot memory boards were designed to fill out the original PC/AT's 512K RAM system to 640K (the name TophAT comes to mind), and these will work here.

The problem is that the 80386 is really designed for 32-bit memory fetches, and 16-bit boards can only output one 16-bit word, rather than one 32-bit word per access. It thus takes the 386 at least twice as long to read the same number of bytes from 16-bit RAM. And if that were not problem enough, the iSBC 386AT operates its 8- and 16-bit slots at an effective clock rate of 8 MHz to allow full hardware compatibility with boards designed for the standard PC/AT. Finally, neither alternate-banking nor address pipelining work for 16-bit memory. Accesses to 16-bit memory installed on the bus can take as much as five times as long as comparable accesses to true 32-bit memory.

The memory organization of PC-DOS Version 3 aggravates the situation further from an operational standpoint. DOS and RAM-resident utilities are loaded into low-memory, below transient applications. The more resident utilities you load, the higher into memory your transient programs get bumped. Ultimately, the lion's share of your fast 32-bit RAM is taken up by DOS and resident programs that execute only rarely, while the bulk of executing code in your transient application may venture above 512K and slow the effective speed of the machine to a relative crawl.

From a memory perspective, the iSBC 386AT would be best applied as a 386 native mode machine, running native mode applications in memory above 1 Mbyte. As native mode operating systems for the 386 are quite new and as yet unproven, little software is available for them, and this promise must, for now, go unfulfilled.

Math Coprocessor Module

The iSBC 386AT contains a socket for the 80387 math coprocessor. The 80387 is the 80386's partner in floating-point math, and is only now becoming available. To fill the gap, Intel has been offering SBCMath, a small daughterboard that plugs into the 80387's pin grid array (PGA) socket. SBCMath contains a 10-MHz 80287 coprocessor, with glue logic to make the 287 electrically equivalent to a 387. Intel says little about the SBCMath module other than that it operates at 10 MHz, asynchronously to the CPU. The company also does not promise that the daughterboard's performance will be equivalent to that of a real 387. The boost in calculation speed is significant, however, when 8087/287/387 knowledgeable code is run on the board. No 80387 was available for comparison, but SBCMath was tested in conjunction with this review.

Intel has disclosed a compatibility problem between the 387 and 386 on early production motherboards. The affected boards carry the number 149422-0XX or 137406-0XX. These boards, however, do work with the SBCMath 80287 coprocessor module.

Setup and Configuration

The iSBC 386AT's electrical design is not impressive. The lack of custom LSI means that the board is tightly packed with ordinary DIP devices, and a truly appalling number of jumper wires was used on all of the boards I examined. Worst of all, no DIP switches are used to facilitate hardware configuration. Instead, no fewer than 14 separate header pin groups are scattered across the board, and default configurations are set by jumpering the pins with shorting blocks.

The jumpers specify things such as the power-up default monitor type, enable/disable keyboard reset, the enable/disable serial and parallel ports, the number and type of extended RAM boards, serial port IRQ number, and coprocessor presence or absence. Although most of these conditions will change only rarely, some of them (such as the default monitor type) change often enough to make locating and changing the shorting blocks an intrusive nuisance. Furthermore, some of the header pin groups are located beneath the mass of cables running to the disk drives and are difficult to change without pulling the machine completely apart.

Once the power-up default conditions are set with the shorting blocks, however, setup of other system parameters is done AT-style, using a SETUP utility provided with the iSBC 386AT. SETUP allows the battery-sustained clock/calendar chip, the diskette drive number and types, the fixed disk number and types, the base and expansion memory, and the installed display adapter to be set. SETUP understands an impressive 47 different fixed disk drives, with capacities up to 127 Mbytes. The list is large, but no facility is included for entering specs for a drive type that is not yet part of the list. If you have an unlisted drive, it may run poorly or not at all if you install it as a drive with close but not identical specs.

The Phoenix ROM BIOS supports the peculiarly named *deturbo* mode, an effective 6-MHz slowdown of the system clock that is included to accommodate sensitive copy-protection schemes. Effective clock speed may be toggled between 6 and 16 MHz with the Ctrl-Alt-1 (keypad) and Ctrl-Alt-2 (keypad). Again, these hot key codes are fixed in ROM and cannot be changed. The speed may also be changed under program control by outputting a control value to I/O port 64h.

Software Compatibility

The iSBC 386AT is extremely IBM compatible from a software perspective. The failures I observed were universally due to copy-protection schemes. Most schemes that failed at 16 MHz passed when the board was throttled down to 6 MHz. The exceptions were boot-only games, since the boot operation must always occur at 16 MHz. Interestingly, one boot-only game that booted at 16 MHz ran in the

same way at 16 MHz as at 4.77 MHz: Gerald Kuperberg's venerable J-Bird. Kuperberg is apparently one of the few game designers clever enough to design CPU speed *out* of his code.

The list of business and software development products that I ran successfully on this machine over a six-month period is long indeed, and the following is only a part: all Borland products, Microsoft Windows, C, Pascal, Quick BASIC, GEM, Ventura Publisher, In-A-Vision, Lotus 1-2-3, Framework II, Crosstalk XVI, Word Perfect, Wordstar, Paradox, Smalltalk V, Personal TEX, Logitech Modula 2, and Halo DPE. In general, my experience would imply that any non-copy-protected PC-DOS business application that will run on an 8-MHz AT will run on the iSBC 386AT. Games and very low level developer's tools might not.

Quarterdeck Office Systems' DESQview, in its latest release, offers support of the 80386's virtual 86 mode, and allows as many DOS partitions as memory will support, with very effective text windowing. DESQview installed easily and ran without incident.

Far more interesting, if somewhat more sensitive, is the Software Link's PC MOS/386, a true native mode 386 operating system that does not require DOS to be present. Rather, it replaces DOS with a native code 386 operating system that shares a compatible API with PC-DOS 3.1. PC MOS introduces a speed penalty somewhat like that of Xenix: noticeable but not crippling. This is to be expected, since the copy I tested supports up to five users and any reasonable number of tasks.

PC MOS/386 took some tinkering to install, but once installed it ran fairly well. Now and then, however, the system simply "went away," implying that the product has not yet reached maturity.

Hardware Compatibility

Hardware compatibility is a more difficult test to pass, since board products are more timing sensitive than software. Even with a bus that operates at an equivalent clock speed of 8 MHz, 386 timing is different enough to cause problems. The Periscope Submarine board and Tall Tree Systems' JLaser both caused problems that the vendors admitted were unavoidable in current releases.

Board products that ran without incident included the Bernoulli Box 10 × 10 controller, Microsoft and Logitech Mouse bus cards, Paradise Autoswitch EGA, MDS Genius VHR video controller, IBM's Game Control Adapter, Tecmar's Graphics Master, D.C. Hayes' 1200B internal modem, and a number of "generic" clone boards containing extended RAM and serial or parallel ports. Several AT-style disk controllers also worked well. Peripherals such as printers, plotters, modems, and mice that operate through standard serial and parallel ports should work without difficulty. Table 1 summarizes all the performance tests.

Conclusion

The iSBC 386AT advantages are that it is fast and can run *hypervisors* like DESQview that allow you to turn ordinary applications into resident applications by putting each in its own virtual 86 partition. True native mode reliable multiuser operating systems such as PC MOS/386, Concurrent DOS-386, and Xenix are now available for the 386, and if you need multiuser ability, the iSBC 386AT is a contender.

As a real-mode superfast AT-compatible, however, the board has an extremely serious shortcoming: It can contain only 512K of fast 32-bit RAM. If you need 640K, you will bleed away the greater part of the CPU's speed advantage in a torrent of wait states and inefficient 16-bit memory accesses every time code is executed above 512K.

Also, the 32-bit extended memory boards are expensive and hard to find. Intel offers a 2-Mbyte extended memory board and has promised an 8-Mbyte board, but has made no effort to market the memory boards widely. At the Spring Comdex Exposition, Fortron Corporation was showing a $700 2-Mbyte board for the Intel 32-bit bus, but it was not available in time to be evaluated here.

Minor problems, such as jumper blocks all over the board, imply that the board was never really intended to become a mass-market product. Rather, it resembles more strongly the engineering evaluation boards from microprocessor companies.

Better 80386-based motherboards will soon be available (for example, the ALR 386/2 and ZEOS International units) based on the Chips & Technologies' 386 AT Chipset. At its current street price of $2000, the iSBC 386AT is no longer especially competitive. §

Jeff Duntemann has written about the microcomputer industry since 1977. He is the author of Complete Turbo Pascal and Turbo Pascal Solutions, *and is Editor in Chief of Turbo Technix Magazine.*

Where to Buy the Intel iSBC 386AT Board

The Intel iSBC 386AT motherboard is sold by most electronics parts distributors that distribute Intel components.

The board is also available from several PC board-level product vendors, including:

Compubyte Inc.
236 German Blvd.
Yaphank, NY 11980
(516) 924-1618

Sabet Electronics
2644 Forest Grove Dr.
Richardson, TX 75080
(214) 644-8306

386 Corp.
14126 Sherman Way,
Ste. 562
Van Nuys, CA 91405
(818) 904-1386

The Intel iSBC 386AT motherboard is also used in systems offered by several mail-order vendors, including:

Corvus Systems Inc.
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San Jose, CA 95119
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Program Interfacing to Microsoft Windows

by William Wong

Part VI—Conclusion

This series of articles has a twofold purpose. First, its intent is to give readers considering purchasing the Microsoft Windows Toolkit and writing a Windows application an insight into what is involved. Its second purpose is to help readers who have purchased the Toolkit or attended a Microsoft Windows seminar to write a typical application.

This final article of William Wong's series on interfacing to Microsoft Windows gives an overview of the major features not yet presented. Complete coverage of each feature would require a much longer article. Currently, the only book available on programming with Windows is *Windows Programming Secrets* by Kris Jamsa, published by Osborne/McGraw-Hill, Berkeley, Calif., although Microsoft will shortly release a book by Charles Petzold. The Microsoft Windows Programmers Toolkit is another good source of information.

Menus and Dialog Boxes

Menus and dialog boxes are the most apparent common items between applications. Windows helps by providing support in a standard fashion, making applications easy to learn once users understand the basic Windows interface.

Menus and dialog boxes are resources created by the resource compiler program, RC. The text input to RC was described in Part II (*MS/J*, March/April 1987) of this series. It can be created by using a text editor or by using the dialog editor program, DIALOG. The dialog editor provides a graphic interface showing what a dialog box will look like.

Each item in a dialog box can be identified, and its status can be queried by an application. A dialog box is displayed using a Windows function that handles the interaction with the user. Applications can use additional hooks to modify this interaction as necessary. In fact, an item in a dialog box, such as a button, is a child window in which the item is drawn.

Menu bars and pull-down menus are created in a similar fashion. There is a limit to what a pull-down menu can contain and the menus do not have to be used. It is up to the application to provide the interaction necessary for its operation.

The main limitation of menus and dialog boxes is that they are bound to an application, and dynamically loading a menu from a different file is a complex procedure.

Dialog boxes and menus simplify programming under Windows; they also make programs look and feel as though they are part of Windows.

Memory Management and Atoms

Windows provides memory management at two levels: local and global. Local memory management is similar to that found in C and DOS, in which a single contiguous space is managed. A local heap is contained within a global data segment and is accessible to a single instance of a Windows application program. A global heap is a collection of segments in the memory made available to Windows when it starts.

Memory blocks or segments are referenced using handles or pointers. The latter can be used only when a block is locked. Blocks can be FIXED, MOVABLE, or DISCARDABLE. C provides the idea of a FIXED memory block that will never move. Windows provides the idea of MOVABLE blocks. A MOVABLE block can change positions during a garbage collection operation, which is normally invoked when a new block needs to be allocated and there is not enough memory available. Windows first moves all MOVABLE blocks to one end of the allocation area and tries to fulfill the memory request. If this fails, Windows starts removing DISCARDABLE blocks from memory. A memory allocation

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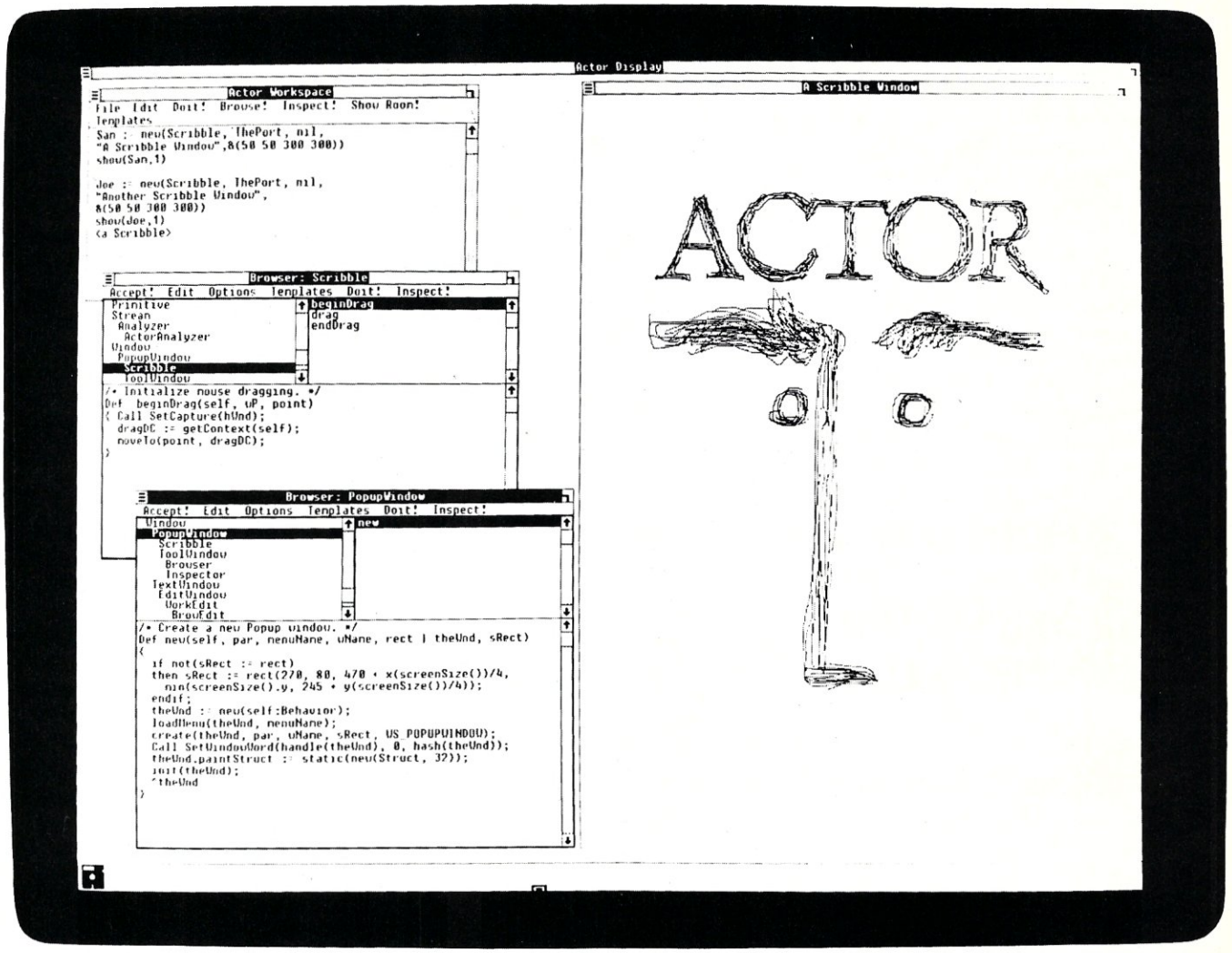

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request fails if there is insufficient memory after performing this process.

MOVABLE and DISCARDABLE memory blocks are a bit tough to access without the additional support from Windows. Essentially, a lock can be placed on a block so it will not move. The application is given a pointer to the current location of the block. It can then manipulate the data and should unlock the block when the application has finished using it. Windows is then able to move a block, but an application must no longer use the pointer to the block. The locking process must be performed each time an application needs access to the data in the block, so the overhead can be expensive for frequent accesses. This approach provides a virtual-memory-like environment and also a cooperative environment like that of nonpreemptive multitasking.

Data and code segments can be movable. Functions in MOVABLE segments require a special preamble and postamble to make sure that a function is in a fixed location when being executed. Windows supplies this support, so it is just a matter of indicating what functions are being used in this fashion.

A block can be marked as DISCARDABLE when it may not be needed, although marking it does not necessarily unallocate it. It is up to the application to reload the data if it has been discarded and is needed again. Blocks in the local heap can be marked such that a function will be called when the block is about to change state. A limited form of virtual memory can be maintained using this facility.

Atoms are text strings that can be added to but not deleted from a Windows-maintained database. Atoms differ from the more conventional memory management support just described but provide a facility that is indispensible. The atom database is used for window class identification as well as being the basis for the Dynamic Data Exchange (DDE) protocol.

Each atom has a number associated with it, and this number can be set at any time. The name of the atom provides a common access method—two applications simply need to know the name of an atom to share data. Each atom also has a unique handle associated with it.

One way to use the atom facility is to allocate a global memory segment and place its handle in the atom database along with an atom. Other programs can then obtain access to the global data using the handle.

Like everything else in Windows, the protocol and data format are cooperatively maintained. Windows imposes no specific use on the atom facility—in fact, the value associated with an atom need not be used. The atom handle is often used to provide a common and unique name for messages exchanged between windows of different applications.

The atom facility and memory management support do not provide a virtual-memory environment, so resources are limited. Adding atoms to the atom database uses up memory resources.

Communications

Access to communication devices under DOS is done by direct hardware manipulation or through the ROM BIOS serial port support. Windows advances the state of the art through its communications driver. A Windows application can open a serial device and specify handshaking methods and buffer sizes, leaving much of the work of sending and receiving data to Windows.

The communications interface is standard among Windows implementations and hides the hardware from the application. It also allows a Windows application to operate in the nonpreemptive multitasking mode without significantly impairing other programs that may be running at the same time. Communication programs that do not use Windows communication support must either hog the processor by polling the communications port or the programs must include custom interrupt driver communications support.

Windows' communications support is somewhat limited and does not provide high-speed handshaking, which may be necessary for some communication protocols. The support is normally adequate for terminal emulation or file transfer protocols such as XMODEM or Kermit, however.

A communications object has a handle associated with it, as do most Windows objects. The communications object must be released by an application program before it terminates.

Printing

Printing using Windows is one of the more difficult tasks, even for text-based output. Essentially, the information to be printed needs to fit into memory unless the printer driver can send drawing-oriented commands in the same way PostScript printers can. Most other printers use a technique called banding.

Banding requires several passes over the drawing database supplied by the application. Each band is set up as a memory device context, and the application draws the picture using the memory device context and then sends the bit map to the printer. The memory device context is clipped to the banding region. The band is then printed and the printer starts printing again. The process is repeated for each band until the application terminates.

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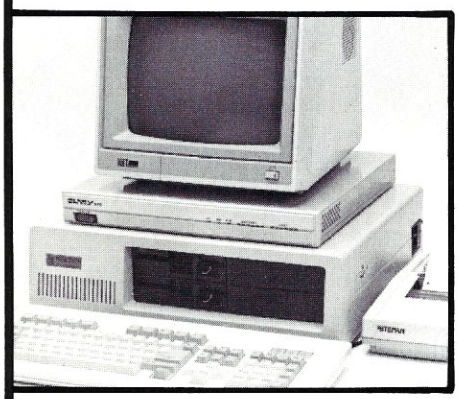

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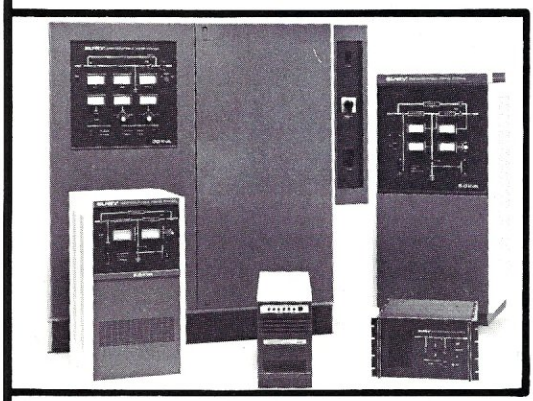

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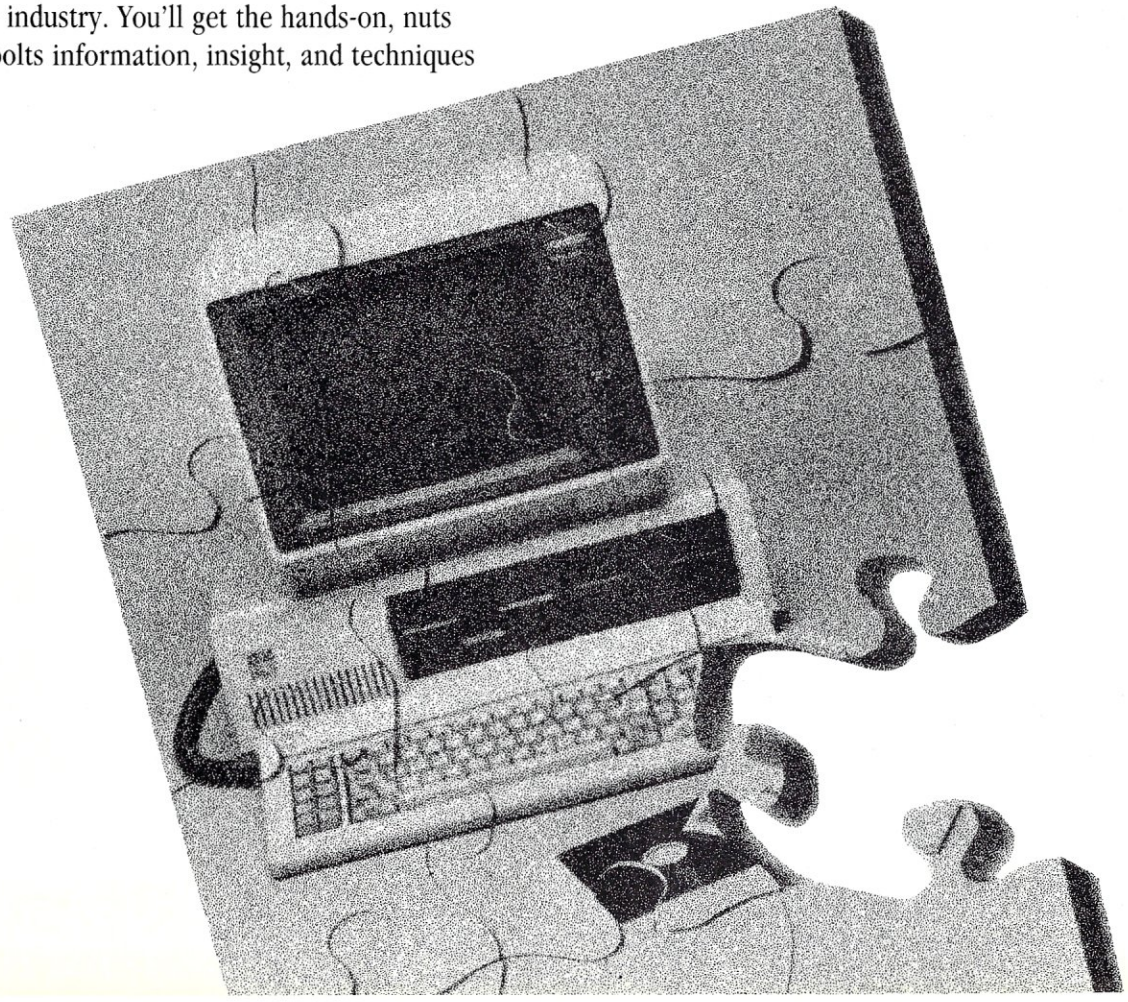

The Clipboard

The clipboard is both an application and a special Windows object that can be owned and manipulated. The clipboard application is really a simple program that can call a display function associated with the clipboard. There is only one clipboard and its owner is the last program that put something into it. Any application can read from the clipboard.

The clipboard is accessed using several functions. But an application must be able to support one or more display methods, such as text, graphics, metafile, and so on. The number and type are not designated, but any application looking at the clipboard can recognize the type of formats available and choose the best one.

The clipboard is normally used to exhange data between programs under user control. The data in the clipboard can be proprietary and may only be recognized by a corresponding program.

Dynamic Linking and Dynamic Data Exchange (DDE)

Windows requires a completely different .EXE file format that is similar to OS/2's. This format is required to support the memory management methods as well as the link between an application and Windows. A Windows application calls a Windows function directly instead of using a software interrupt, as in DOS. This approach requires the .EXE file to contain the name of the called functions so that Windows can resolve the reference when the program is loaded. This process, called dynamic linking, provides an efficient interface and allows the environment to be flexible. It is even possible for an application to use the dynamic linking mechanism to access non-Windows functions. This is done by creating a dynamic link library module that can be loaded upon request. The dynamic link process provides one method of intertask communication because multiple programs can have access to a dynamic link function.

Dynamic Data Exchange (DDE) is a mechanism that is built upon existing Windows functions, including the dynamic link facility, atoms, and message passing. DDE allows tasks to exchange data, notify other tasks when data is available, and receive information in an asynchronous fashion. DDE functions allow a program to identify a service using the atom facility, which maintains a unique name for the service. Other programs can then access this service using the same name. A service also provides several subservices that are named in the same fashion. DDE communication begins when a second task identifies a service and obtains the associated window handle from the atom facility. It then sends a message to the window requesting the service.

The data that can be exchanged may be single records, a stream of records, or complete records of information when available. The data can include text or binary data as well as window or memory handles. DDE is a standard protocol that Microsoft supports and recommends, and is being included in more and more applications, allowing a flexible working environment.

DDE has many applications. It is one method for linking a spreadsheet to another program—for example, linking a graphing program to a communications program that returns the latest stock quotes. The DDE facility will become more important as more programs that support it become available—for example, OS/2 Version 1.1, which will contain the Presentation Manager.

Windows 2.0, OS/2, and the Presentation Manager

Windows, Version 1.03, has been available for some time. The next major release, which has already been demonstrated by Microsoft, will be Windows 2.0. From a programming point of view, little will change with Windows 2.0. There are some protocol changes and some additional functions, but existing applications will run under it.

Windows 2.0 has one major change for users—tiled windows are no longer the norm; pop-up windows are everywhere. Windows 2.0 improves the user interface in other ways, too. For example, the up and down arrows, which were on the side slider, have now moved to the top-right portion of the title bar. This allows quick scrolling using the buttons with the mouse by simply moving left or right and pressing the mouse button.

OS/2's Presentation Manager will look a lot like Windows 2.0. The new pop-up windows will be there along with other improvements. Applications designed for Windows will not run under the Presentation Manager without major changes, however, for several reasons. First, OS/2 is a preemptive multitasking system whereas Windows is nonpreemptive. Second, the programming interface is based upon a new set of functions that are a combination of Windows and an IBM mainframe graphics interface. The new features should allow better performance of multitasking programs and shorten the development cycle for new programs.

Summary

Microsoft Windows is a viable base for developing PC-DOS/MS-DOS applications. Movement from 1.xx to 2.x is painless, but porting applications for either version of Windows with OS/2 and the Presentation Manager becomes more difficult.

Developing new applications for Windows is a new approach to programming. Windows applications require a great deal of initial support, making small and simple programs impossible, although creation of programs becomes easier once a familiar program base is built.

Program development with the Microsoft Windows Toolkit is a high-cost, high-performance investment. Practical development requires an AT-class machine with at least a 20-Mbyte hard disk.

Hopefully, this set of articles has presented the Windows development environment in a light that shows its magnitude as well as its flexibility. §

Bill Wong is president of Logic Fusion, Inc., 1333 Moon Dr., Yardley, PA 19067, a systems software development firm.

WRITING WINDOWS APPLICATIONS

Windows applications cannot be written in MASM or C alone. This is because the linker must understand Windows objects (for example, icons, dialog boxes) and linking to Windows is through a special call linkage, not an INT *instruction.*

To write a windows application program, you need the Windows Toolkit ($500 list, but discounted to as little as $309) and the latest version of either Microsoft C, MASM, or Pascal. Microsoft conducts seminars for windows application programmers at which the Windows Toolkit package is distributed. Programmers who buy the Toolkit without attending the seminars are handicapped because the manuals contain little theory. This series of articles should assist programmers who buy the Toolkit without attending the seminars to write Windows application programs. It should also help seminar attendees.

The Whitewater Group (Technology Innovation Center, 906 University Pl., Evanston, IL 60201; (312) 491-2370) has introduced Actor, a lower-cost alternative to the Microsoft Windows Toolkit. Its documentation is poorer than that of the Toolkit, however, because it deals primarily with the Actor programming language.

Dealing with the DB-9 Serial Port

by Sol Libes

IBM changes interface connectors on its mainframe and minicomputers frequently, most often just to hurt the competition. When it introduced the PC/AT, it introduced a new connector for its RS-232-C serial port—a DB-9 instead of the old DB-25-type connector. The DB-25 had been in use for so long that it had become a standard for serial interfacing. This time I agree with IBM's decision to change connectors. And other manufacturers are also switching as they see the advantages.

The RS-232-C serial interface standard has been defined by the Electronic Industries Association (EIA). *RS* stands for Recommended Standard, and the *C* indicates that this is the third version of the standard. The standard utilizes a 25-pin connector, and manufacturers generally agreed on the DB-25-type connector with the modem (the Data Communications Equipment, or DCE) being a female connector and the terminal or computer (the Data Terminal Equipment, or DTE) being a male connector. Until the introduction of the IBM PC, however, manufacturers used male and female connectors as they wished.

The EIA standard defines the function of 20 of the 25 pins, and it specifies how many must be used. There was a time when modem interfaces used most of the pins. Over the years, however, modem hardware interfaces have become simpler as computers and modems have become more intelligent. The current generation of modems uses only nine lines. Serial interfaces to printers require even less wires—typically only three.

Why then use a 25-pin connector when a 9-pin connector will do? As computers get physically smaller, the room for connectors becomes more limited. Also, manufacturing costs have become more important in today's highly competitive marketplace. It is therefore only natural that computer manufacturers seek a connector better suited in size and cost to today's needs.

The DB-25 25-pin serial connector will no doubt be a thing of the past in a few years. Unfortunately, today it is still popular, and it is often annoying to have to connect a serial modem or printer with a DB-25 connector to a computer with a DB-9 serial I/O connector.

It is not difficult to make up a DB-9 to

Figure 2. RS-232 pin functions

RS-232C Name	Connector Pin Nos. DB-25	DB-9	Signal Name	Signal Direction
AA	1	*	(Chassis Ground)	common
BA	2	2	TxD (Transmit Data)	output
BB	3	3	RxD (Receive Data)	input
CA	4	7	RTS (Request to Send)	output
CB	5	8	CTS (Clear to Send)	input
CC	6	6	DSR (Data Set Ready)	input
AB	7	5	SG (Signal Ground)	common
CF	8	1	DCD (Data Carrier Detect)	input
CD	20	4	DTR (Data Terminal Ready)	output
CE	22	9	RI (Ring Indicator)	input

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Figure 1. DB-9 to DB-25 interconnections

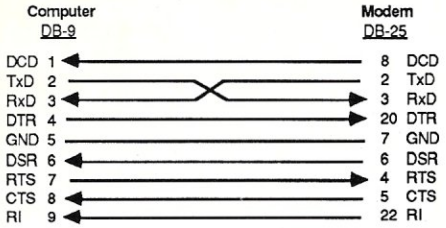


Figure 3. Null modem wiring, DB-9 to DB-25

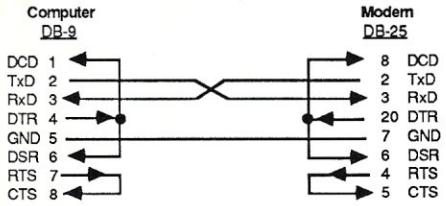


Figure 4. Null modem wiring, DB-9 to DB-9

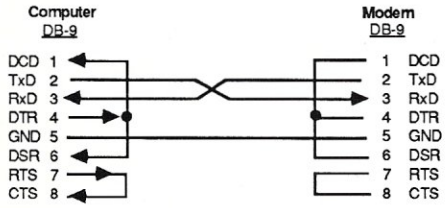


Figure 5. DB-9 to Diablo 630 interconnections

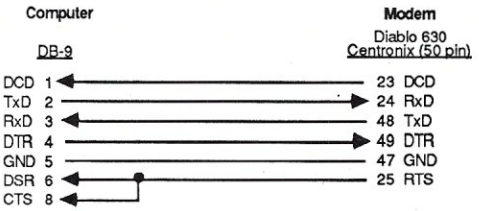


Figure 6. DB-9 to Qume Sprint 9/45 interconnections

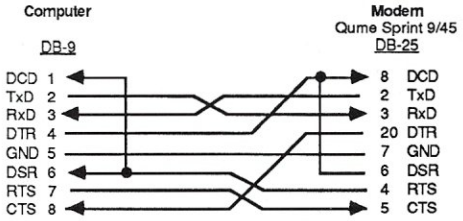
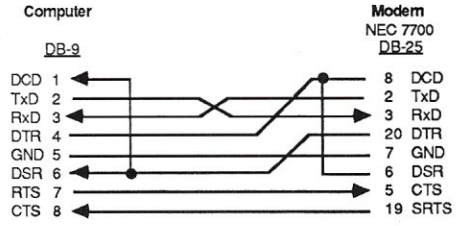


Figure 7. DB-9 to NEC 7700 interconnections



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DB-25 adapter cable. You need three parts: a DB-9S female connector with hood assembly, a DB-25P male connector with hood assembly, and some nine-conductor shielded cable. I keep the cable length short, typically about one foot. The hood assemblies should be metal or metalized plastic to reduce EMI-RF radiation, and the shield should be connected to the metal parts of the connectors. The cable assembly should be constructed as shown in Figure 1. Figure 2 provides information on the function of each line.

A null modem type connection is used when connecting one computer to another computer or a terminal to a computer. The wiring for a null modem type cable using DB-9 to DB-25 connectors and DB-9 to DB-9 pin connectors is shown in Figures 3 and 4.

Several printers also use serial interfaces. It is unfortunate that there is no standard pinout for serial printers—for example, the Diablo 630 uses a Centronix 50-pin connector. The cable wiring for this machine is shown in Figure 5. Many serial printers use the DB-25 connector. The wirings for two popular serial printers (the Qume Sprint 9/45 and NEC 7700) using the DB-25 connector are shown in Figures 6 and 7. §

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A Linker for Turbo Pascal

by Sung K. Soh

Expanding Turbo Pascal's Code Space Using a Module

Turbo Pascal compiles quickly, produces tight code, and, with its built-in editor, is convenient to use. Turbo Pascal, however, does not support large memory models; compiled-code size must be smaller than 61K. As the built-in library of Turbo Pascal occupies about 10K, a programmer can use only about 50K for code space. Using overlays is not an attractive prospect, especially when unused memory is available. Most programmers have a collection of procedures and functions that are used again and again in a variety of programs. In Turbo Pascal, those procedures and functions have to be included and compiled every time such subprograms are used. This repetition may increase compile time needlessly.

This article describes a method of overcoming this code-size restriction. A separate file of Turbo Pascal source code that contains frequently used procedures and functions is compiled by Turbo Pascal into a .COM file. This .COM file is used as a library module, and the functions and procedures included in it can be called from other Turbo Pascal programs (master module). The compiled library module is loaded onto the heap space of the master module during run time, so a library module, once prepared, neither occupies precious code space nor wastes compile time. Currently, there are several commercial packages on the market that accomplish the identical task. Presented here is a do-it-yourself method without the automation and convenience of commercial packages, but it is free and gives the user complete control over the linking process. It has been tested on Turbo Pascal Version 3.01A and is likely to work on Versions 2.0 or 3.x without modification.

LIBRARY MODULE

Begin by collecting Turbo Pascal subprograms (procedures and functions) in one or more Pascal source files. They must be

Listing 1

```
{ This program tests Turbo Pascal Linker
  (C) Copyright 1987 by Sung K Soh
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  readers allowed.
  All other rights reserved. }

{$I TEST1.PAS}
{$I TEST2.PAS}

{ Procedure linker will generate  necessary call instructions to
  enable calling of module procedures from main program. }

PROCEDURE linker;
 BEGIN
  INLINE($58/                          { POP AX }
         $2E/$A3/*+23/                 { MOV CS:* + 23, AX }
         $8B/$E5/                      { MOV SP, BP }
         $5D/                          { POP BP }
         $58/                          { POP AX }
         $2E/$A3/*+13/                 { MOV CS:* + 13, AX }
         $D1/$E6/                      { SHL SI,1 }
         $BB/* + 23/                   { MOV BX, * + 23 }
         $03/$DE/                      { ADD BX,SI }
         $2E/$FF/$17/                  { CALL CS:[BX] }
         $EA/$00/$00/$00/$00);         { JMP Return Address }
 END;

{ Main block of module. Replace test1/test2/ sequence by a lsit
  of subprograms to be called by far call. }

BEGIN
 INLINE($B4/$00/                       { MOV AH, 0 }
        $CD/$21/                       { INT 21 }
        test1/test2/linker+7);         { List Of Addresses }
END.
```

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Greenleaf Functions (296 useful C functions, all DOS services)	$160
Essential C Utility Library (400 useful C functions)	$160
Essential Communications Library (C functions for RS-232-based communication systems)	$160
PC/IP (CMU/MIT TCP/IP implementation for PCs)	$100
B-Tree Library & ISAM Driver (file system utilities by Softfocus)	$100
The Profiler (program execution profile tool)	$100
Entelekon C Function Library (screen, graphics, keyboard, string, printer, etc.)	$100
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tested thoroughly, as errors may be difficult to locate after their incorporation into a library module. Global variables may be used in the library module, but they will share the same data space with the master module. If you have to use global variables, it is a good idea to copy the variable declaration statements of the library module and place them exactly in the same order at the start of the master module, before any other global-variable declarations of the master module. This ensures that the shared global variables will be assigned identical addresses when they are referenced by the library module and by the master module. Avoiding use of global variables in the library module makes the module more portable and is recommended.

. . . a library module, once prepared, neither occupies precious code space nor wastes compile time.

Make a list of library-module subprograms that will become "public," i.e., the subprograms that can be called from the master module located outside the code segment of the compiled module. Note that other "private" subprograms may exist in the compiled module, and that they may be called freely from within the module, but they will be inaccessible from outside the module. This inaccessibility helps in hiding unnecessary details, and thus makes the compiled module more modular. Assign tag numbers 0, 1, 2, and so on to the public subprograms.

Now create a Turbo Pascal source file that will be compiled to produce the library module by modifying Listing 1. Replace the {$I} compiler directives, which include TEST1.PAS and TEST2.PAS, so that they will include your subprograms instead. Include the procedure linker, which acts as an intermediary between the library module and the master module, just before the start of the main block of the library-module program. The main program of the module is used to store the addresses of the subprograms. Replace the list of the names of the library subprogram in the in-line code, *test1/test2/* in Listing 1, with the names of your public subprograms. They must be ordered corresponding to the tag numbers assigned. For example, if you have three subprograms named *proc0*, *proc1*, and *proc2*, corresponding to tag numbers 0, 1, and 2, respectively, you then replace *test1/test2/* with *proc0/proc1/proc2/*.

Now compile the prepared source with Turbo Pascal using the C compiler option, so the resulting .COM file will be saved on disk for later use.

PREPARING INC FILE

After the compiled library module is pre-

Listing 2

```
{ LINKER.INC
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  by Sung K Soh
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  readers is allowed.
  All Other Rights Reserved. }

{ Include this file in the main program to use compiled module. }

TYPE FilenameString = STRING[80];

VAR  LinkerAddr : ^INTEGER;

PROCEDURE initialize_linker(Filename:FilenameString);

 VAR F   : FILE;
     FIB : ARRAY[0..37] OF INTEGER ABSOLUTE F;
     size: INTEGER;

 BEGIN
  {$I-}
  ASSIGN(F,Filename);
  RESET(F);
  FIB[1]:=1;
  Size:=FILESIZE(F);
  FIB[1]:=128;
  GETMEM(LinkerAddr,Size+256);
  MOVE(MEM[CSEG:0],LinkerAddr^,128);
  BLOCKREAD(F,MEM[SEG(LinkerAddr^):OFS(LinkerAddr^)+256],
            FILESIZE(F));
  CLOSE(F);
  {$I+}
  IF IORESULT<>0 THEN WRITELN(^G,'Link Failed')
  ELSE
   BEGIN
    LinkerAddr:=PTR(SEG(LinkerAddr^),OFS(LinkerAddr^)+Size+244);
    LinkerAddr:=PTR(SEG(LinkerAddr^),LinkerAddr^);
   END;
 END;

{ Copy procedure and function declarations to be called and
  include the inline code. Note that SI will be set equal to the
  serial number of module which must match the reverse order of
  addresses stored in the compiled module.  }

PROCEDURE test1(VAR x:REAL;i,j:INTEGER);
 BEGIN
  INLINE($BE/$00/$00/                    { MOV SI, 0 }
         $0E/                            { PUSH CS }
         $BB/LinkerAddr/                 { MOV BX, LinkerAddr }
         $FF/$2F);                       { JMP [BX] }
 END;

FUNCTION test2(g:REAL):INTEGER;
 BEGIN
  INLINE($BE/$01/$00/                    { MOV SI, 1 }
         $0E/                            { PUSH CS }
         $BB/LinkerAddr/                 { MOV BX, LinkerAddr }
         $FF/$2F);                       { JMP [BX] }
 END;
```

pared, you must prepare an INC file, which will be included in the master module whenever subprograms in the library module are called. It can be prepared by modifying Listing 2. Replace subprograms test1 and test2 in Listing 2 with function or procedure declarations of the subprograms in the library module. In the case of the previous example, they will be declaration statements for proc0, proc1, and proc2. Copy the in-line code for test1 and test2 of Listing 2 for each and every subprogram that replaces test1 and test2. Change the second byte of the in-line codes, $00 and $01 for test1 and test2, respectively, with the tag numbers you assigned for the library subprograms: $00 for proc0, $01 for proc1, $02 for proc2, and so on. These tag numbers are assigned to the source index register SI before calling the procedure linker in the library module, so the procedure linker can determine which library module is called.

USING THE LIBRARY MODULE

Compile your master module, which includes the INC file just prepared, using the {$I} compiler directive before any reference to the library subprograms are made. After the {$I} directive is used, the library subprograms can be referenced as if they are declared in the master module. Before any library subprograms are called and before any heap space is used by a pointer variable in the run time, however, the procedure initialize_linker in the INC file must be called with the file name of the compiled library file as the argument.

The main program of the module is used to store the addresses of the subprograms.

It must not be called again. For example, if the file name of your compiled library module is LIB.COM, then the following statement must be executed before any subprogram in it can be called:

```
Initialize_Linker('LIB.COM');
```

CONCLUSION

A Turbo Pascal linker program that works similarly to the ones on the market is described. It expands the effective code size of Turbo Pascal beyond 64K, yet the internal workings of the linker are transparent to the calling program and the subprograms called. The described method may be easily automated by users. §

Dr. Soh is an assistant professor of chemical engineering at the University of Detroit. He is also vice-president of SoftTech, Inc., which specializes in mathematical and engineering software for PC-DOS/MS-DOS microcomputers. He can be reached at the University of Detroit at (313) 927-1410 or at SoftTech, Inc., (313) 544-8544.

The author has an automated version of the described method available. It can be purchased for $15.00 and is in PC-DOS/MS-DOS format only. Orders can be placed with SoftTech Inc., 14640 La Belle, Oak Park, MI 48237; (313) 544-8544.

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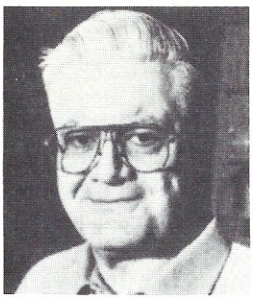

FORTRAN Translation and Freelance Plus

Technical Word Processors

In this column I want to catch up on some software reviews. First, however, I would like to draw your attention to some extensive reviews of technical word processors (TWPs) that have resulted from a project of the IBM PC Technical Special Interest Group of the Boston Computer Society.

This project had two phases. The first phase dealt with the ability of TWPs to reproduce various types of equations, matrices, and diagrams. The work on this was done in 1985 and the report was published in the January 1986 issue of the *Notices of the American Mathematical Society*. The second phase, in 1986, posed a tougher benchmark: the automatic generation of numbering schemes as part of the generation of equations, tables, figures, references, chapters/sections, lists, headers, footers, footnotes, endnotes, and indexes. The report on this effort is much more extensive, covering some 68 pages of small type in the January, February, and March issues of the *Notices of the American Mathematical Society*. You can get a reprint of it for $12 from Carl Hein, Dunster House Apt. 7, Swanson Rd., Boxborough, MA 01719.

I was involved in both of these efforts to some extent, having volunteered to try to do the benchmarks using TEX. I succeeded, but only by subjecting TEX to some tortures that it was never intended to handle. For example, you are not supposed to draw diagrams or prepare such things as indexes with plain TEX, but the program is powerful and general enough to handle such tasks. It was a tremendous learning experience for me. The report makes interesting reading and I recommend it to you.

RTC Plus

Cobalt Blue has produced a translator program to convert FORTRAN and RATFOR programs to C ($450). The first version sent to me for review handled only the RATFOR-to-C translation. However, revisions that allowed some translation of FORTRAN also began arriving, so I held off the review until the FORTRAN translation seemed to have stabilized. That now appears to be the case, although I have no doubt that further improvements will be made.

It is the job of a compiler to translate a higher level language to assembly language; thus, a compiler is in fact a translator program. The target language is generally quite simple, but, being low level, it issues many instructions for every higher level statement that is translated. In the case of a translator program such as the one under review, both the original and target languages are high level and are likely to have very different syntaxes. Hence, the task of the translator program is generally more difficult than that of a simple compiler. It is not surprising, then, that RTC Plus neither claims nor delivers the ability to do 100 percent translations.

First, a word about RATFOR since this is generally not a well-known language. I reviewed both RATFOR and the Software Tools computing environment in the September 1983 issue of *Microsystems* magazine. *Software Tools* was in the first instance a book by B. W. Kernighan and P. J. Plauger (Addison-Wesley, Reading: 1976). These authors showed how to write a large number of utilities in a largely machine-independent way (only the lowest level made contact with the system). At the time, C was not widely available; most computing systems had FORTRAN in common. Thus Kernighan and Plauger wrote a FORTRAN preprocessor as one of the utilities and called it RATFOR (Rational FORTRAN). They also wrote all of the utilities in RATFOR, including RATFOR itself. RATFOR has many structures that are borrowed from the C language.

The Kernighan and Plauger utilities generally duplicated those available in UNIX. Thus there was established the Software Tools User Group (STUG), which had as its goal bringing some of the advantages of UNIX to other systems that could compile the tools using FORTRAN. STUG also promoted the use of RATFOR as a substitute for C on systems that did not have it.

The occasion for my previous reviews was the porting of Software Tools to CP/M. There was a subsequent port of Software Tools to PC/MS-DOS. The company responsible for these ports (Carousel MicroTools) has long since ceased to do business, and it is not likely that there are many RATFOR users presently using microcomputers. But RATFOR is generally available on UNIX systems, and it is possible that a number of people who have used it there would wish to transport their RATFOR programs to microcomputers and then convert them to C. That was probably the original motivation behind the development of RTC Plus.

I did not become a confirmed user of RATFOR. Generally, the FORTRAN compilation process was long enough, and the addition of the RATFOR preprocessing time on the front end became too frustrating. What I did learn were the techniques used to translate RATFOR statements into FORTRAN. I found it useful to apply some of these techniques in writing FORTRAN programs, and thus I would characterize my exposure to RATFOR as a learning experience that let me write better FORTRAN programs. With the establishment of IF ... THEN ... ELSE statements in FORTRAN 77, even the use of some of these special procedures ebbed away.

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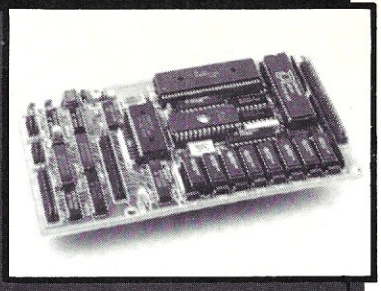

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The RTC program was developed to translate RATFOR into C, but there is a much bigger market for translating FORTRAN programs into C. Thus Cobalt Blue developed FRAT, a program for translating FORTRAN into RATFOR—just the opposite of the normal approach. The standard sequence of operations using the Cobalt Blue scheme has four stages: (1) Use FRAT to convert FORTRAN (*.for* extension) to RATFOR (*.r* extension); (2) use PRTC, a RATFOR preprocessor, to produce an intermediate file characterized by a *.rc* extension that normally disappears after processing (unless there are errors); (3) use RTC to produce a nearly final C program (*.cc* extension); (4) finally, use a postprocessor CPOST to clean up a few things and produce the final C program (*.c* extension).

There are two levels at which these procedures can be used. Someone who wants a rough-and-ready translation to C can just go ahead and run these programs blindly. Some errors may be flagged that will need to be corrected before the translation sequence will go to completion. The experienced user may modify the FOR-

Listing 1

```
This is a Fortran recipe from Numerical Recipes.
Given an array DATA of length N, the program returns
its mean as AVE and its variance as VAR.
      SUBROUTINE AVEVAR(DATA,N,AVE,VAR)
C.....Copyright (c) 1985 Numerical Recipes Software
      DIMENSION DATA(N)
      AVE = 0.0
      VAR = 0.0
      DO 11 J = 1, N
      AVE = AVE + DATA(J)
11    CONTINUE
      AVE = AVE / N
      DO 12 J = 1, N
      S = DATA(J) – AVE
      VAR = VAR + S * S
12    CONTINUE
      VAR = VAR / (N – 1)
      RETURN
      END
```

Listing 2

```
Program translated to Ratfor:
# Translated by FRAT, v1.23, on 6-21-87 at 18:23:13
subroutine avevar(data, n, ave, var)
#.....Copyright (c) 1985 Numerical Recipes Software
dimension data(n)
ave = 0.0
var = 0.0
do j = 1, n {
      ave = ave + data(j)
      11 continue
      }
ave = ave / n
do j = 1, n {
      s = data(j) – ave
var = var + s * s
      12 continue
      }
var = var / (n – 1)
return
end
```

Listing 3

```
The Cobalt Blue C version:
#include <stdio.h>
#include <f77c.h>
#include <swtdef.h>
```

TRAN code somewhat before submitting it to translation, and will make use of many command line switches on these different programs. Cobalt Blue warns that many FORTRAN constructs will have to be rewritten to get a good translation, and that certain statements, such as those containing I/O statements will have to be hand-translated in any case. One can envision that a truly clever translation process would do all these things automatically. I suppose the Cobalt Blue translation process may make significant progress toward this goal in subsequent versions.

I tested RTC Plus by using it to translate 202 FORTRAN routines taken from *Numerical Recipes*, by W. H. Press, B. P. Flannery, S. A. Teukolsky, and W. T. Vetterling (Cambridge University Press, New Rochelle, New York: 1986), which I have mentioned before in this column. These routines form a library of procedures that do not have I/O statements, although a few of them use complex numbers that RTC Plus does not like either. The advantage of using these routines is that Press, *et. al.*, are bringing out a version of their recipes in C, and Bill Press kindly provided me

Listing 3, continued

```
/*Translated by PRTC-RTC, v1.42, on 6-21-87 at 18:23:44*/
/*Translated by FRAT, v1.23, on 6-21-87 at 18:23:13*/
VOID /*FUNCTION*/ avevar(data, n, ave, var)
int *n;
float data[], *ave, *var;
{
int j;
float s;
/*.....Copyright (c) 1985 Numerical Recipes Software */
(*ave) = 0.0;
(*var) = 0.0;
{int tmpa_0 = (*n);
for(j = 1; j <= tmpa_0; j += 1 ){
      (*ave) = (*ave) + data[j - 1];
      L_11:
            ;
      }}
(*ave) = (*ave) / (*n);
{int tmpa_1 = (*n);
for(j = 1; j <= tmpa_1; j += 1 ){
      s = data[j-1] - (*ave);
      (*var) = (*var) + s*s;
      L_12:
      ;
      }}
(*var) = (*var) / ((*n) - 1);
return;
} /* end of func */
```

Listing 4

```
The Numerical Recipes C version (alpha copy):
void avevar(data,n,ave,svar)
/* Copyright (c) 1987 Numerical Recipes Software */
/*200401*/
float data[],*ave,*svar;
int n;
{
      int j;
      float s;
      *ave = (*svar) = 0.0;
      for(j = 1; j <= n; j++) *ave += data[j];
      *ave /= n;
      for(j = 1; j <= n; j++) {
            s=data[j] - (*ave);
            *svar += s * s;
      }
      *svar /= (n - 1);
}
```


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with an alpha copy of these routines. These provide an independent human-translated set of C programs against which the translations can be compared.

Of these 202 FORTRAN routines, 36 encountered some problem and did not go to completion. A common problem would be a statement like *ERROR: intrinsic function args must all be the same type, (pass2),* which would be a complaint against a common FORTRAN coding practice. RTC Plus also does not like to have array dimensions passed to a subroutine. In a few cases, internal errors were reported, which Cobalt Blue has warned is not supposed to happen but may happen due to as yet unreported bugs.

Perhaps we should dwell less on the unfortunate 36 routines that failed and consider that 166 were translated satisfactorily. These routines have what a C programmer would consider very clumsy C, but most of them should do what they are supposed to do. You can get the flavor of the translation process by looking at the code in Listing 1. This is a short and simple FORTRAN routine, AVEVAR, which provides the mean and variance of an array of numbers. Listing 2 shows the translation to RATFOR and then to C; also shown for comparison is the hand-translated version of this subroutine.

The goal of a good compiler is to provide tight and efficient machine language code. From Listing 3 we can see that RTC Plus does not presently produce tight and efficient C code. But many will find it helpful in partially automating the translation process.

Freelance Plus

Freelance Plus is an interactive chart and plot program published by the Lotus Development Corporation and available for $495. I was interested in seeing if this type of program was becoming particularly useful for scientific work. I found it somewhat disappointing in that respect, but then I was probably expecting too much. The program does what it was designed to do quite well.

In some respects it operates in the same way as a paint program. Its use of PC monitors, however, is restrictive. If you want to see things in color, you need an EGA monitor, since a CGA monitor shows only monochrome. The program works well with a Hercules card, and input can come from the keyboard or a mouse.

Work is normally done with a number of graphic elements: text, lines, arrows, rectangles, circles, arcs, marker symbols, and polygons. You can also do freehand drawing on the screen, however. Text is generated with a subset of the Hershey vectorized fonts and with thick sans serif fonts called "Swiss" (meaning Helvetica style). These can be rotated and scaled. Also available are software raster fonts in fixed sizes called "Sigma" fonts. The other graphics elements are usually created on the screen and then manipulated by translation, rotation, scaling, flipping, or other distortions. Clearly, the intended purpose of these operations is to prepare presentation material. Scientists may find the material useful for this purpose, since much of their work involves proposal writing. But I do not find it useful for presenting scientific results.

In addition to supporting output on graphics screens, Freelance Plus supports some film recorders, a variety of plotters, a number of dot-matrix printers, and the Hewlett-Packard Laserjet. The lack of support for page description languages such as PostScript is surprising and disappointing. Much of what Freelance Plus is trying to accomplish involves the same kinds of manipulations that are available in PostScript.

A number of scientists input data into Lotus 1-2-3 spreadsheets for analysis and plotting. For most purposes, that is as far as they need to go. However, 1-2-3 files (as well as a few other kinds of files) can be input into Freelance Plus and manipulated further. One might want to add boxed labels, for example, to a scientific plot. Scientists may find the program useful for this type of work.

As for my personal preference, I find it more useful to approach the problem of plotting in a different fashion. In most cases I am plotting one or more dependent variables against an independent one, and the dependent variables are obtained from a FORTRAN computation of some sort. In these cases I find it useful to write a FORTRAN program to utilize this data in preparing a PostScript file to be sent to an Apple LaserWriter. This can use the LaserWriter's internal fonts, which look at least as good and usually better than the Freelance Plus fonts.

There is also an interactive plotting program called Mongo that was developed by John Tonry at the Center for Astrophysics. The program is easy to use for graphics primitives and has the advantage that all the interactive commands have equivalent FORTRAN calls that can be included in FORTRAN programs. It was developed on a VAX, and the program has spread so that it is now available on Sun workstations and on PCs. Both of the latter implementations take output to a LaserWriter. I would be more attracted to Freelance Plus if it had these capabilities.

The Screen Manager

While we are on the subject of screen displays, I would like to take brief note of The Screen Manager, a series of program elements published by Concept Software ($149.95). Libraries and calling sequences are provided in assembler, C, and FORTRAN that allow the display of windows of arbitrary shape (as long as they are rectangles) on the screen. Text may be written to these windows (or read from them). The windows may be visible or invisible and can overlay one another. They can also be moved around the screen at will. Foreground, background, and border colors and other attributes can be changed at will. Cursors are maintained for all windows in use. Windows and their contents can be stored to and recalled from disk files.

The libraries sent for review included Microsoft C and FORTRAN, Lattice C, and Lahey FORTRAN. Probably other compilers and more recent versions of the above compilers are available now.

These routines are more likely to be of interest to commercial program developers than to typical scientists, who often develop a FORTRAN program and then run it once to get the answer to some problem. But quite a few programs become production items, run many times. In such cases, it may be worthwhile to display results in specific windows on the screen while the program executes. These libraries allow you to do that. §

A. G. W. Cameron is professor of astronomy at the Harvard-Smithsonian Center for Astrophysics.

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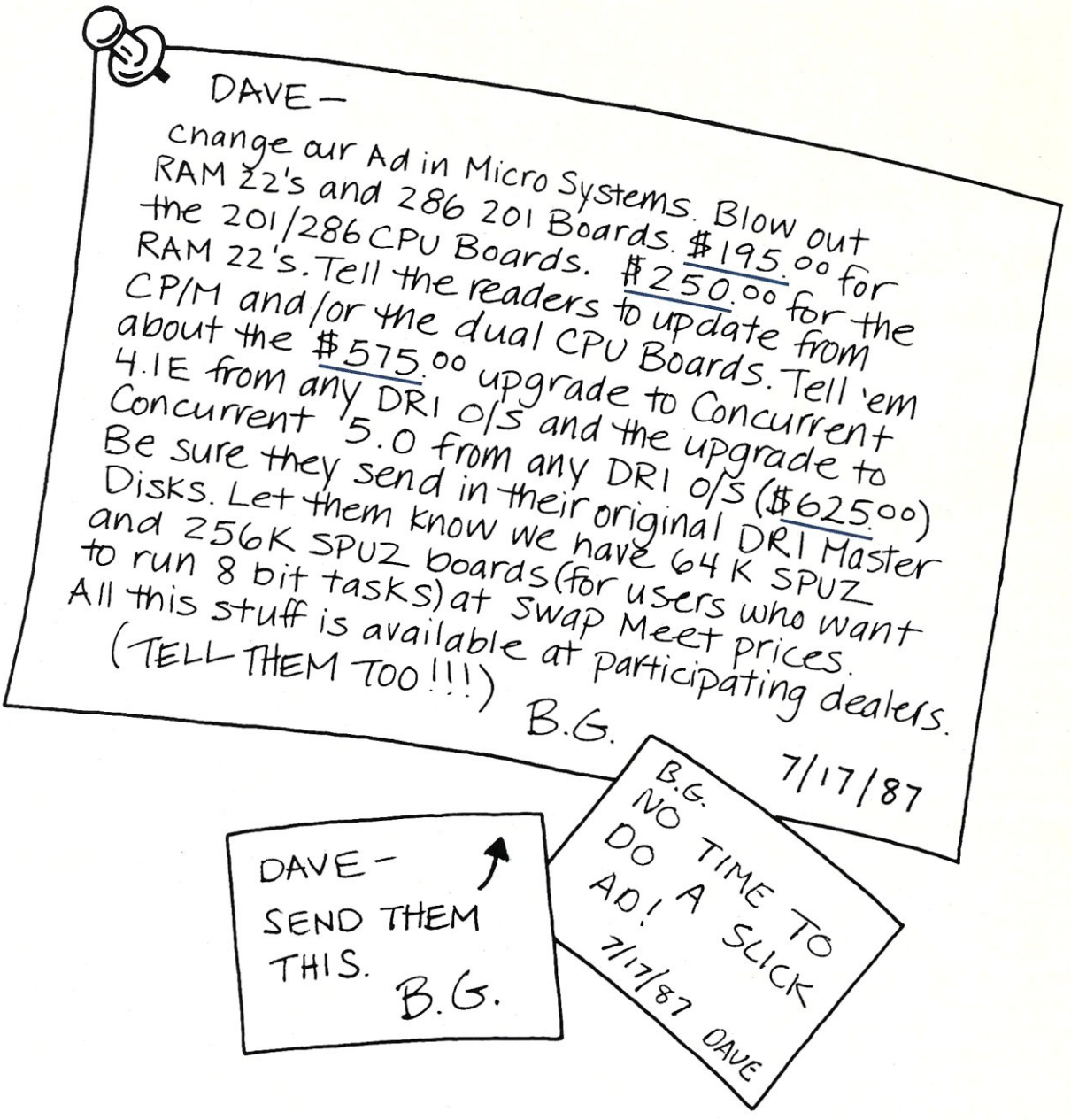

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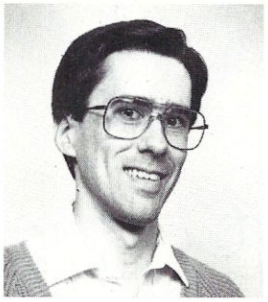

A Public Domain UNIX Clone and a C Programming Book for UNIX Users

This column discusses the UNIX operating system. If you have comments or questions about UNIX or this column, please write to Ian Darwin at Box 603, Station F, Toronto, Ontario, Canada M4Y 2L8. If you have UNIX mail access to the uucp network, mail "ihnp4!darwin!ian." Internet users should try "ian@darwin.uucp" or "ian@sq.com." I can't always answer immediately, but I will get back to you; electronic mail gets answered first!

What's GNU? Source for You

The GNU project is another attempt to rewrite a UNIX-like system without any reference to AT&T source code. And it could lead to a full-function, UNIX-like system that you can get for free, with full source code to put up on any 386 system.

But GNU will not spell the end of companies that make their living by supporting commercial UNIX systems. Since people are free to sell supported GNU systems, however, some of those companies may well switch from selling supported UNIX (which they must distribute without source) to supported GNU (distributed with source). There is a place for public domain programs and systems in the technical community. Most business computer users want a stable, established product, so they will continue to buy AT&T UNIX from vendors who will provide ongoing support for it.

However, GNU should someday keep older UNIX systems alive and support new ones, as well as freeing people from AT&T's source-level pricing policies. For now, the Free Software Foundation has a number of GNU subsystems available, including the Emacs editor, a C compiler and source debugger, a chess program, and a compiler-compiler tool, and more software is being released as it is completed.

GNU (the "g" is pronounced) is a project of the Free Software Foundation (FSF), and is intended to produce a working clone of Berkeley UNIX. The FSF is primarily run by Richard M. Stallman, who is perhaps best known in the computing community for having invented a comprehensive editor program called Emacs. Emacs differs from most editor programs in several ways. For example, it allows you to change every mapping of a key to a command. The Emacs default simply inserts into the edit buffer printable characters that you type. But if you prefer the feel of an editor like *vi* in which letters are commands, you can simply map the letters to the appropriate commands, which can make Emacs look like *vi*, or WordStar, or KED/EDT, or almost any other screen editor. (Just try making WordStar look like Emacs!) Some editors allow limited mapping of function keys, but I know of no other editor that is completely reprogrammable. Yes, I do mean programmable. You aren't limited to changing the key-to-function mapping; you can also replace the existing functions, or even add your own, if you can write them in the LISP programming language.

Stallman invented the Emacs editor, originally as a set of Editor MACroS for an enhanced MIT TECO editor. His view is that an editor is not an Emacs unless it is extensible, customizable, and self-documenting. His original Emacs ran on MIT's Incompatible Timesharing System (a pun on CTSS, the Compatible Time Sharing System) and was later ported to TOPS-10 and TOPS-20. An early Emacs clone was Multics Emacs, written by Bernie Greenberg using MacLisp as its extension language, rather than obscure TECO macros. Later clones included James Gosling's UNIX Emacs, which uses the Mock-Lisp extension language, a language with LISP syntax but not LISP data structures. Gosling's Emacs is now sold and maintained by Unipress. There are several microcomputer Emacs-like editors that aren't true Emacs because they are not extensible or self-documenting, but they have screens and default keyboard mappings that look like real Emacs. They are more powerful than the editors most micro vendors provide.

Stallman has also been instrumental in shaping the MIT AI lab over the years, and in developing the ITS timesharing system, a multiuser, networked operating system. Recently, Stallman came out with a new Emacs called GNU Emacs. The good news is that it can be copied and customized by anyone, because full source is always provided. The curious news is that it's perhaps the first text editor to come complete with a political ideology wired in.

Stallman gives away software free but maintains the right to control how it is redistributed by copyrighting all the software in the name of the Free Software Foundation. The copying policy is clearly stated in every program and manual FSF distributes. GNU Emacs even has a key combination that displays the copying policy. You can copy the software for any purpose, but must always give credit to the FSF as the originator. Further, if you modify the software and then redistribute it, you must make clear that you are distributing a modified copy, saying who modified it, and when. Finally, if you distribute a binary-only copy, you must distribute an offer of free matching sources, available to anybody, and assignable. In other words, anyone who gets a binary program must be able to get the matching sources. The recipient can redistribute the binary, as well as redistribute the right to get the matching sources.

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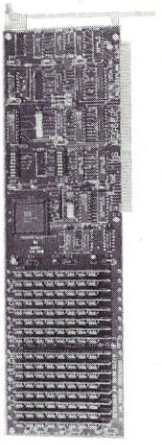

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Some detractors label Stallman a communist. Others call him an eccentric. To those who believe in what he's doing, he's an idealist or evangelist, putting his own professional survival on the line to show the world a better way to make computers more useful. Whatever the ideology, FSF has produced some large and impressive works. Although a full UNIX-like system isn't ready yet, the following items have already been released, including:

- GNU Emacs—A full Emacs editor, including LISP function extensibility;
- bison—A replacement for the *yacc* parser generator;
- gcc—A C compiler, compatible with the draft ANSI C standard, with code generators for the VAX, 68000, and 68020 (gcc tries to make it easy to write new code generators; it's not limited to the preceding machines, and comes with info about porting to other processors. Users have written, and contributed, prototype code generators for the NS32032 and the IBM 370);
- gas—The GNU assembler, currently in beta test;
- gdb—A source-level debugger for the C language;
- chess—A serious chess-playing program;
- Scheme—A "simplified, lexically scoped dialect of LISP," developed primarily at MIT; and
- miscellany—FSF also distributes MIT's X Window System (which is in the public domain) and a version of the *Hack* adventure game.

That's only what is available already. Stallman also has GNU shell (*gsh*, a *csh* emulation), which is in alpha test, and most of the commonly used UNIX utilities working in-house. The kernel will probably derive from the MACH project at Carnegie-Mellon University, or possibly from the TRIX system written at MIT. And most of the rest of a UNIX clone is now in test or development. Many people in the UNIX community and other parts of the industry (VAX/VMS users, non-UNIX supermicro users) support the idea of a full-blown, UNIX-like system with source availability, and they are contributing their time and energy to expand and improve this software. It's hard to say when the system kernel and utilities will be released, but new software is released periodically and eventually there will be a working kernel and utilities for a full UNIX-like system.

What will it mean? People who want to do kernel development on a Berkeley-like UNIX system will no longer need to obtain an AT&T source license (which costs about $60,000 for System V) and then get a Berkeley license; they can get the whole package from FSF for the cost of a tape. Better yet, they can get it from a friend for no cost at all!

To the owner of an orphaned 68000 or similar computer. . . GNU will mean that a UNIX-like system with source code is now available. . . . GNU is designed for modern processors that will continue to be popular . . .

To the owner of an orphaned 68000 or similar computer—those whose manufacturers have gone bankrupt or who have stopped supporting older machines—it will mean that a UNIX-like system with full source code is now available. One can even envision small entrepreneurs making a modest living by supporting orphaned UNIX computers. Such machines, which now sell for about $4,000, might make good systems for hobbyists willing to port GNU.

What will GNU mean to owners of smaller machines? Recall that GNU is meant to be a clone of Berkeley UNIX, not of V6 or V7. GNU is designed for modern processors that will continue to be popular over the next few years, not for processors (like the 8088) that have been obsolete for years. Berkeley UNIX is not small. Don't ever expect to run GNU on your PC/XT, nor probably on your AT or on your PDP-11. For such machines, Tanenbaum's MINIX system (described in this column in the May/June 1987 issue of *M/SJ*) is a better bet. MINIX is also a UNIX system clone, but one designed from the start to run on small systems. Version 7 of Comer's XINU system (reviewed here in the March/April 1987 issue of *M/SJ*), while not a UNIX clone, does have some of UNIX's functionality, and was designed for use on the LSI-11 processor.

GNU expects 32-bit integers and 32-bit pointers, with 8-bit-byte addressing. It also requires at least 1 Mbyte of RAM, and a sizeable hard disk—40 Mbyte is a bare minimum capacity but 80 Mbyte is the recommended minimum. To be able to use demand paging and relocation, expect to upgrade an existing 68000 to a 68010 or 68020 chip, plus have a memory management unit, such as the M68451. Inexpensive machines like the Macintosh 2 or an existing UNIX supermicro are good candidates. A full-blown 80386 system with adequate RAM and hard disk also would make a good GNU machine.

By contrast, MINIX will work on a PC with 256K and two floppies, but keep in mind that it's MIN-ix, a minimal UNIX clone. MINIX is owned by Prentice-Hall and they do not encourage copying. They allow minor copying, on author Andy Tanenbaum's insistence, but not large-scale redistribution. For example, posting Tanenbaum's complete MINIX distribution to the USENET network or on a bulletin board system would be discouraged. And Comer's XINU is copyrighted—you cannot legally give it to your best friend.

FSF, on the other hand, actively encourages people to copy GNU and give it to their friends. It also provides tape duplication services because such services are convenient for some recipients and also because these services provide an easy way for users to donate money to the GNU project in a way justifiable to management. There is no attempt, though, to prevent massive duplication by anybody. If you can find a million people who will buy it from you, then that's a million more who have heard of free software, which is the goal of the FSF. You can post GNU software to the net, assuming the net is happy with its size, or put it up on a BBS, as long as you follow the copying policy.

Interestingly, vendors of UNIX and UNIX-like systems are encouraged to distribute GNU software with their systems. Again there is no license fee, but the copy-

ing rules must be followed. FSF software also comes with extensive documentation. If you order the software from them, you pay a modest fee for the tape and shipment. You can also order neatly printed copies of the manuals.

For details on what's currently available, current copying policies, status, and future plans, contact the Free Software Foundation Inc., 1000 Mass Ave, Cambridge, MA 02138, or call (617) 876-3296.[1]

A Book on C for Berkeley Users

In contrast to books that attempt to cover all aspects of using various UNIX systems, Nigel Horspool at the University of Victoria has written *C Programming in the Berkeley UNIX Environment* (Prentice-Hall, Scarborough, Ontario, Canada, 1986). The book is aimed at students who have some programming experience and includes such topics as the standard features of the C language; the standard C library; system calls and library routines; debugging (there are cursory comments on *adb*, *sdb*, and some detail on *dbx*, whereas most UNIX books cover only one of these); advanced system features such as pipes, and signals; and an overview of networking and terminal handling. Appendixes cover the *vi* text editor, the Berkeley shell *csh*, and summaries of the C language and the library calls. There is a list of answers to the exercises and an index. Many topics that are commonly omitted or inadequately discussed in other books, such as correct use of C language header files, the *make* program, and so on, are included here.

The book discusses only Berkeley UNIX and C; it makes no attempt to cover other UNIX variants. That is at once the book's strength and its greatest weakness. Although it does cover the relevant material, it does not take enough pains to detail what is portable to other UNIX systems and what is not. I suspect this may be simply because Horspool has not been exposed to enough other systems. For example, he uses the library function *bcopy* as though it were a standard part of all UNIX systems, which it's not. He refers to *mail* (with a lowercase m) as the program that prints a header list and reads your *.mailrc* file, but on non-Berkeley UNIX systems that name invokes a different mail program, and the one he describes is invoked (if it's available at all) under the name *Mail* (capital M) or *mailx* (mail extended). And he states that Kernighan and Pike's *The UNIX Programming Environment* is "intended to be a companion to System V UNIX" because it omits the Berkeley system calls; in reality, Kernighan and Pike have described a common subset of Research UNIX (V7/V8), System V UNIX, and (with a few exceptions) Berkeley UNIX.

In fairness, Horspool does refer the reader who is interested in portability to another source. Having administered UNIX systems myself in both the commercial world and academia, and having taught undergraduates about UNIX, I contend that students should not emerge thinking that they know the one true UNIX version. They should be taught what is portable and what isn't. All the world is not a VAX, nor does all UNIXdom run 4.2BSD. More footnotes on the differences would be a big help, as would more consistency. For example, in the discussion of signal handling, Horspool explains the correct procedure for checking whether signals are currently being caught, but not one of his examples uses it. And he introduces *malloc* on page 48, with examples, but he does not mention until page 108 that you must check the return value from it. It has been my experience that students rely heavily on examples, often starting to experiment with some feature of the system by typing in an example from a book, so it is important that the examples be correct.

Despite these minor flaws, the book covers the material that it promises. Recognizing that no one book will satisfy every UNIX user all the time, I would recommend that this book be given serious consideration for use in undergraduate teaching. §

Ian Darwin is Director of Research and Development for SoftQuad Inc., Toronto developers of quality UNIX-based publishing software. Ian previously administered UNIX systems, and organized and taught the undergraduate UNIX course, at the University of Toronto.

[1] John Gilmore of Nebula Consultants provided significant information on GNU and Emacs for this section. Portions of this column were derived from material copyrighted by Gilmore and by the Free Software Foundation.

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The A/D12B32 is $995, and is manufactured by Industrial Computer Designs Inc., 31364 La Baya Dr., Westlake Village, CA 91362; (818) 889-3179.

Break 640K Memory Barrier on an AT and Run Concurrent Sessions

The Software Link AT Gizmo and Multi-Link Advanced software are a hardware/software combination that allow AT-compatible machines to run most PC applications in multiple sessions. It provides a shared-processor, multiuser, multitasking system that lets up to 17 applications/users share the AT. The Gizmo is a card that attaches to the 80286 motherboard and remaps memory creating up to 8 Mbytes of extended memory when used with an Intel Above Board-286. Each user/application can occupy up to 600K of memory in multiple partitions. All applications can now take advantage of the LIM (Lotus/Intel/Microsoft) expanded memory. Up to 16 ASCII terminals can operate with a single host AT-compatible using standard RS-232 connections. Record- and file-locking are provided for multiuser and networking support of applications such as RBASE System V, Smart and dBASE-III Plus.

The suggested retail price for Multi-Link Advanced is $595, and a multitasking-only version (MTO) is $195. The AT Gizmo is $295. All are available from: The Software Link, 8601 Dunwoody Pl., Ste. 632, Atlanta, GA 30338; (404) 998-0700. The Above Board-286 has a suggested retail price of $745 (with 512K RAM) and is available from Intel Corp., 5200 N.E. Elam Young Pkwy., Hillsboro, OR 97124; (800) 538-3373.

AT Replacement Battery

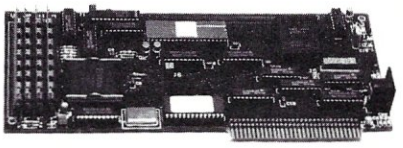
International Battery Corp. has announced the Tadiran replacement lithium battery for AT-compatibles. The battery is listed by Underwriters Laboratories and hence has passed all UL tests for aging,

short-circuit, crush, heat and fire tests. The unit is guaranteed for three years in-use and ten years of shelf life.

The IBC Tadiran replacement battery is $27.50 and can be ordered directly from IBC, 6860 Canby Ave., Ste. 113, Reseda, CA 91335; (818) 609-0516.

Compact, Rugged PC/XT Compatible

Slicer has introduced the SLY40-XT Turbo, a PC/XT-compatible that company sources state is ideally suited for industrial applications. This computer is composed of 17 low-power CMOS integrated circuits and resides in a 4¼-inch × 9¼-inch printed circuit board. It uses an NEC 8-MHz V40 and supports one full megabyte of zero-wait-state RAM. The SLY40-XT Turbo also fea-



tures up to 64K of ROM, a PC/XT keyboard connector, an 8087 socket, and a serial port.

For more information, contact Slicer, 34509 Snelling Ave. South, Minneapolis, MN 55406; (612) 724-2710.

OTHER HARDWARE PRODUCTS

Co-Processor Controls Clock Rate

Everest International Marketing Inc. has introduced Zipper, a 80287 math co-processor that can be set to its own optimal clock speed (up to 10.6 MHz) without changing crystals or math chip. The resulting acceleration of all programs that make constant calls to the chip is ideal for such applications as CAD/CAM/CAE and spreadsheets. The Zipper board plugs right into the 80287 socket (no expansion board) and the existing chip is placed on the Zipper board. The Zipper can then control the 80287's independent clock. With the Zipper is a software interface, the Zip-It utilities, that allow interactive control of the math chip's clock speed.

Zipper carries a suggested retail price of $159. For more information, contact Everest International Marketing, 633-470 Granville St., Vancouver, British Columbia, V6C 1V5; (604) 684-4187.

2.2 Gigs on One Cassette

Emerald Systems has adapted helical-scan recording technology used in video recording and introduced VAST, Virtual Archival Storage Technology. The recording technology uses the familiar approach to magnetic recording but at greater data density and speed. Using helical scan, a disk can be backed up to tape at a speed of 15 Mbytes per minute. Emerald's new VAST Device can store up to 2.2 Gbytes of data on a single tape cassette the size of a pocket cal-

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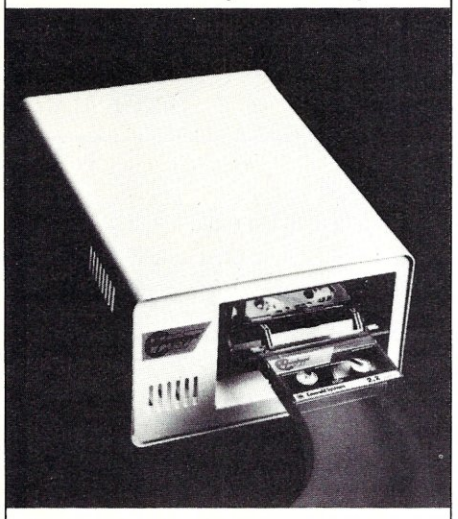
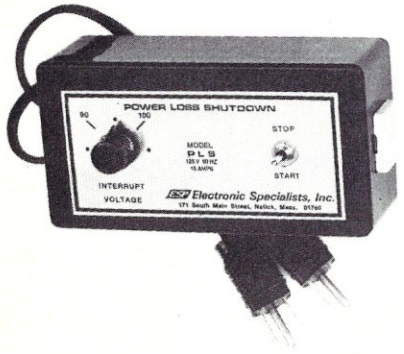
culator. Originally developed for high-end storage for desktop PCs (beyond 250 Mbytes), but company sources say it is ideal for use with LANs and file services with disk volumes beyond 183 Mbytes.



The VAST Device sells for $69.95, and cassettes are available in four sizes: 250 Mbytes, 500 Mbytes, 1.0 Gbytes, and 2.2 Gbytes. For more information, contact Emerald Systems Corp., 4757 Morena Blvd., San Diego, CA 92117; (619) 270-1994.

Power Loss Shutdown

Electronic Specialists have announced the PLS Power Loss Shutdown unit to protect microcomputers operating on UPS or SPS power supplies. It powers down the system if commercial AC power has not yet been restored when the UPS or SPS batteries have discharged. This prevents undesired



computer and power system start-up after a power outage. Models with adjustable AC line drop-out voltage level also are available to accommodate the inherent brownout protection capabilities of most UPS systems.

The PLS is $150 and is available from Electronic Specialists, Inc., 171 S. Main St., Natick, MA 01760; (800) 225-4876.

NEW SOFTWARE PRODUCTS

SQL Applications for 286/386

Oracle Corporation has released SQL*QMX, a query and report writer that allows users of 286 and 386 machines to develop SQL-based applications under DOS 3.1+. The new product is a compatible superset of IBM's Query Management Facility (QMF) and like QMF, provides a reporting and two query environments: Query-By-Example (QBE) and SQL commands. The easy-to-use report formatting capabilities also allow flexible presentation of query results, either interactively or in hard copy.

SQL*QMX operates with IBM PCs running Professional ORACLE and is priced at $395. For more information, contact Oracle Corp., 20 Davis Dr., Belmont, CA 94002; (415) 598-8157.

Lifeboat for Graphics Programmers All at C

Lifeboat Associates has introduced a new graphics library for C programmers, Advantage Graphics. According to Lifeboat executives, Advantage Graphics provides C programmers with an expanded, comprehensive set of drawing functions, and the added performance necessary for designing multiple-window applications. The package also offers Advantage Plot, full support for a broad range of plotters. The Advantage Graphics library supports IBM PS/2 Models 30, 50, 60, and 80, as well as the PC/XT/AT. It is also compatible with a wide variety of C language compilers, including Lattice C, Microsoft C, and Borland Turbo C.

The Advantage Graphics library is available for $250.00. For more information, contact Lifeboat Associates, 55 S. Broadway, Tarrytown, NY 10591; (914) 332-1875.

FORTRAN Programming Utilities

Fortran Power Tools from PJN International offers a collection of programming utilities to simplify program development on the PC. For example, the cross-reference utility not only generates source code with detailed cross-referencing maps for variables, subprogram calls, and labels, but it also can scan multiple sources files to compile an alphabetical list of subprograms and tree diagrams of global routines. Other utilities in the library include file print, routine extract, file append, case change, and more.

Fortran Power Tools runs on IBM-compatible systems with DOS 2.0 or higher. It is available for $119.95, plus $3.50 shipping and handling, from PJN International, P.O. Box 200423, Austin, TX 78720; (512) 258-1235.

Easing Software Installation

The Software Factory has created a new set of tools to assist application and software developers when installing new software. EZ-Install provides a thorough installation program that offers more than printed installation instructions of .BAT files. EZ-Install allows the programmer to check disk and memory space, check files, check disk drives and directories, check DOS versions, and to give messages or take appropriate actions.

Along with EZ-Install, The Software Factory has introduced EZ-Paint, screen painter that allows the end user to interact with your program through menus and forms. Using the screen-painting technique, EZ-Paint provides control over foreground and background colors, color intensity, line font, field choices, text placement, menu choice threading, and other elements.

EZ-Install is available for $99; EZ-Paint for $40. For more information, contact The Software Factory, 15301 Dallas Pkwy., Ste. 750, Dallas, TX 75248; (214) 490-0835.

Software Configuration Management Utility

The Boston Software Works has released Version 6 of its BSW-Make software configuration management utility. Patterned after the UNIX-make utility, BSW-Make Version 6 automatically constructs program executables using information in a "makefile," which assures developers that only those files that have been modified since the program was last built will be compiled or assembled and linked into a new program executable. The Version 6 is now available for PCs running MS-DOS/PC-DOS, and for DEC VAX computers running VAX/VMS.

BSW-Make Version 6 sells for $89.95 for MS-DOS. For more information, contact The Boston Software Works, 120 Fulton St., Boston, MA 02109; (617) 367-6846.

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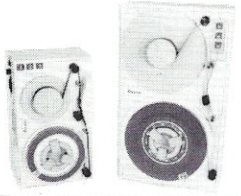

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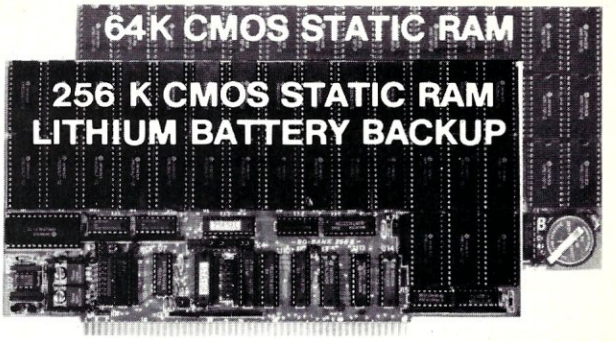

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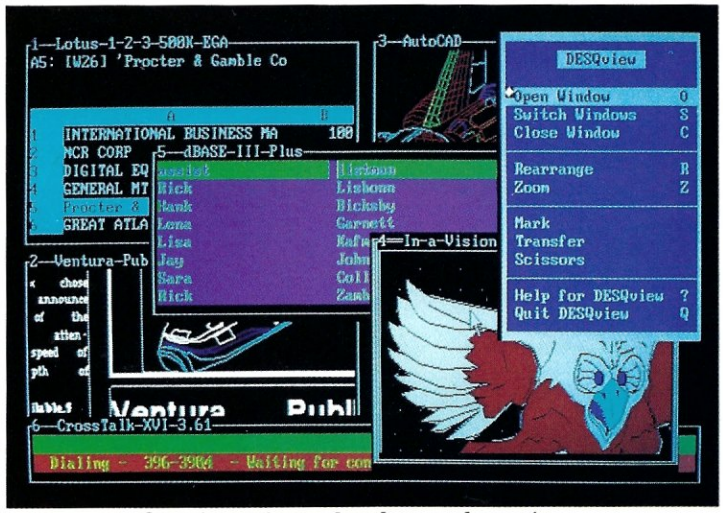

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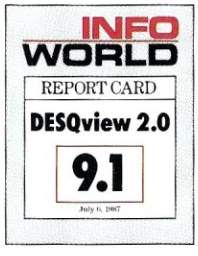

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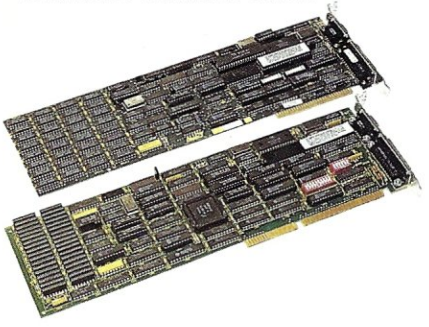

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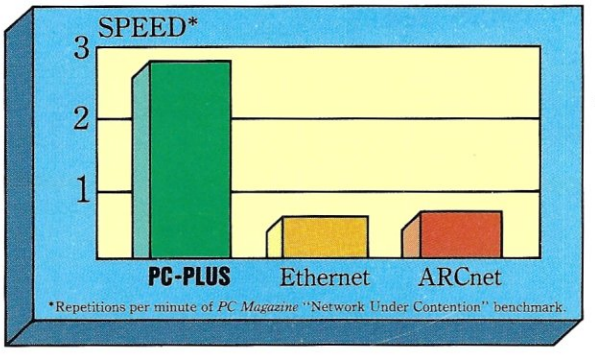
We put the computing engines all in one place — in the server. Not spread all over the building. And our LAN software is truly easy to install. Use PC-PLUS with your choice of AT compatible servers or with Personal System/2.™ Add a card and terminal to grow. Simple RS-232 twisted-pair data cables — no expensive rewiring with coax. You can often use existing telephone cable. Convenient packaged solutions, including Alloy's NTNX™ network software.

PC-PLUS Runs With Personal System/2

With Alloy's new HI/2™ Micro Channel™ interface, you can connect PC-PLUS to IBM's new Personal System/2 Model 50, 60 or 80 computers. Use Alloy's 4, 8, 12 or 16 slot expansion boxes to build PC-PLUS networks with PS/2 file servers. Or choose our PLUS4/PS for a simple, preconfigured 4 workstation network.

PC-PLUS: Find Out Before You Invest

A local area network is a long term investment. Today's applications are just the beginning. Make sure your choice is ready for tomorrow — with mainframe connections, remote access, graphics and the power for growing database applications. To find out more about PC-PLUS, call or write Alloy today at (617) 875-6100.



PC-PLUS™ The No-Nonsense Network

ALLOY COMPUTER PRODUCTS

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